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ABSTRACT

Achievement Tests in biology, chemistry, physics, earth and space science were administered to 100,000 students in grades 4, 8, and 12. The tests did not reflect course content, they were based instead upon five goals: understanding of scientific concepts, processes, applications, safety, and literacy. A panel judged that performance was less than satisfactory for 70% of the items on the grade 12 test, compared to 30% on the grade 8 test, and 18% on the grade 4 test. Boys performed better than girls on concepts, applications and safety. Over 9,000 students in grades 7, 9, and 11 responded to an attitude questionnaire. Most felt positive about science, scientists, and science courses, but were neutral or undecided about scientific ideas and careers. The 3,500 science teachers surveyed were dissatisfied with preservice and inservice training. The need to improve leadership facilities, equipment, and instruction varied with instructional level. Junior secondary teachers were least content. Twenty-one recommendations specific to grade levels were made. Improvements in instruction and teacher training at the junior secondary level were of greatest concern. Almost 40% of the students avoid science after grade 10; furthermore, many of the junior secondary teachers prefer other subjects or grades. (CP)

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SCIENCE ASSESSMENT
1978

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General Report

Volume 1

A REPORT TO
THE MINISTRY OF EDUCATION,
SCIENCE AND TECHNOLOGY

-TM 800387 1042-

BRITISH COLUMBIA SCIENCE ASSESSMENT

GENERAL REPORT

VOLUME I

(PROCEDURES, STUDENT TESTS, CONCLUSIONS AND RECOMMENDATIONS)

Submitted
to
The Ministry of Education
British Columbia

by
The Science Assessment Contract Team

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January 1979

JUN 20 1980

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The Contract Team wishes to thank the many people whose co-operation and involvement made this assessment possible. First of all, we wish to express our appreciation to the teachers of science and their students who completed the tests and questionnaires. We are also extremely grateful for the critical reviews and judgements provided by the members of the Review Panels, the Interpretation Panels, and the staff members and students of the schools in which pilot tests were conducted.* And too, we could not have carried out this assessment without the expertise and technical knowledge provided by Mary Cooper and Glen Forrester of B.C. Research. In addition, we wish to give special thanks and recognition to Bob Aitken, the staff of the Learning Assessment Branch and the members of the Management Committee for their help and great encouragement.

We appreciate also the co-operation of the staff at Print Services, Publication Services Branch in producing the tests. Other people who provided valuable assistance were Florence Pieronek (U.B.C. reading specialist), Jim Gaskell, Linda Erickson and Marsha Boseman.

Throughout the project, Marg Francis of U.B.C. played a key role. This report was typed by Beth Buchanan of U.B.C.

We would like to pay tribute here to the memory of the late Klaus Lundin of Alpha Secondary School in Burnaby, who, as a member of the Management Committee, not only inspired us with his enthusiasm but also guided us with his knowledge during the early stages of the assessment.

PREFACE

This report is the result of a team effort. In Volume I Ted Hobbs was mainly responsible for Chapters 1 and 5, the section on the design of the achievement tests in Chapter 3, and the description of the grade 12 achievement results in Chapter 4. Walter Boldt drafted Chapter 2, and the section describing the design of the attitude instrument in Chapter 3. Terry Quelch drafted the section on the results of the attitude survey in Chapter 4. Gaalen Erickson drafted the sections describing the sampling procedures in Chapter 3, and the results of the grades 4 and 8 achievement tests in Chapter 4. Gerry Sieben was responsible for Volume II which deals with the teacher survey. Ted Hobbs was responsible for the final draft of the report, and Olga Bowes prepared the material for printing.

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CHAPTER 1
THE ASSESSMENT

1.1. Purposes of Assessment

The B.C. Science Assessment was part of the on-going Provincial Learning Assessment Program. General guidelines of procedure for assessment are described in Assessment Planning: B.C. Assessment Program (British Columbia Department of Education, 1975), as are the purposes of assessment which may be summarized as follows:

1. To monitor student learning over time.
2. To inform the public of the strengths and weaknesses of the public school system.
3. To provide the province and individual districts with information which can be used to maintain strengths and overcome identified weaknesses.
4. To assist curriculum developers at the provincial and local levels in the process of improving curriculum and developing suitable resource materials.
5. To provide directions for change in teacher education and professional development.
6. To provide information that can be used in the allocation of resources at provincial and district levels.
7. To provide directions for educational research.

The program is not concerned with the assessment of specific courses such as Physics 12 or Science 9, but is designed to cover a broad range of subject matter with a stress on those skills that are needed to function effectively in society.

1.2. Terms of Reference

The terms of reference of the science assessment are specified in a document issued by the Learning Assessment Branch, Ministry of Education, in February 1977, entitled Terms of Reference: Formation of Contract Teams in Science and Written Expression.

Under these terms of reference, tests and questionnaires were to be developed by a group under contract to the Ministry of Education. This Contract Team was to operate with the guidance of a Management Committee consisting mainly of school science teachers and Ministry of Education officials.

The issues to be addressed by the science assessment are listed in the terms of reference as follows:

1. What are the goals and objectives of science?
 - a) What are the existing goals of the B.C. curriculum?
 - b) What goals and learning outcomes are important for the future and should be included in a future curriculum?
2. To what extent are students in grades 4, 8 and 12 achieving the desirable goals and objectives of a science program?
3. The following questions relate to the teaching/learning process and are presented here as suggestions only. It is assumed, however, that information of this type is desirable and will be of benefit to the decision makers.

What kinds of materials and resources are teachers presently using?

What instructional methodologies are being employed in their classrooms?

What are the needs of teachers in the area of in-service?
4. After examining the information emerging from questions 1, 2 and 3, what recommendations can be directed to the following groups?
 - a) Curriculum developers at provincial and local levels
 - b) Teacher educators (pre-service and in-service)
 - c) Those responsible for the allocation of resources
 - d) Educational researchers

The terms of reference call for multiple choice science achievement tests at the grades 4, 8 and 12 levels, as well as questionnaires for teachers. Results were to be reported for the province as a whole, and for individual school districts. The Ministry of Education took responsibility for preparing district reports, each of which is confidential to the district concerned.

1.3. Outline of Procedure

The science assessment began in the spring of 1977 with the formation of the Contract Team and the Management Committee. The compositions of these groups are given in Appendix A. In cooperation with the Management Committee, the Contract Team prepared a framework of objectives for a set of science achievement tests and a list of areas to be investigated in a teaching/learning survey. At the same time, the Contract Team began to compile a bank of multiple-choice science test items, and to prepare an instrument to measure attitudes towards science and scientists.

The framework of objectives was revised on the basis of recommendations made by Review Panels specially constituted by the Ministry of Education, in June of 1977.

Items in the bank were classified according to the framework of objectives. Then, according to specifications agreed upon by the Management Committee, a set of pilot tests was prepared by the Contract Team. These pilot tests were administered to a sample of British Columbia public school students in the fall of 1977. On the basis of the item analysis, and in consultation with the Management Committee, the Contract Team prepared final versions of the science achievement tests in the spring of 1978. These achievement tests were distributed by B. C. Research to all public schools in the Province to be administered to every pupil¹ in grades four, eight and twelve who was at school on the day of testing.

A few weeks after the achievement testing, four other instruments were administered. One instrument consisted of two parts: (1) a survey of students' attitudes towards science and scientists, and (2) a set of questions dealing with students' perceptions of the science teaching practices to which they had been exposed.

The other three instruments were three versions of a teaching/learning survey, with separate versions being directed to elementary school teachers, junior secondary school science teachers, and senior secondary school science teachers respectively. The three questionnaires covered such aspects of science teaching and learning as curriculum, textbooks and other printed materials, apparatus and science equipment, physical facilities for teaching, teacher education, leadership, and instructional practices.

The attitudes survey instrument was answered by a sample of grades seven, nine, and eleven students, while the teacher questionnaires were administered to samples of elementary, junior, and senior secondary science teachers.

Selection of all samples, distribution of instruments, collection of results, and analysis of data were carried out by B.C. Research.

The results of the achievement tests were examined by Interpretation Panels specially constituted by the Ministry of Education in June, 1978.

Volume I of the General Report contains descriptions of procedures connected with the science achievement and attitude testing, the results of tests, and a summary of conclusions and recommendations. Volume II of the General Report consists of descriptions of the procedures and results of the teacher survey. A shorter description of all procedures and results is contained in the Summary Report.

The Contract Team has by no means exhausted all the possible uses of the results of the various tests and questionnaires, and researchers are advised to investigate further the rich source of data available in the science assessment. To this end, a number of possibilities for additional work with the present data are presented later in this report, along with some suggestions for further related research.

¹ With a few exclusions as described in Chapter 3.

CHAPTER 2
GOALS AND OBJECTIVES

This chapter deals with the procedures by which the goals and objectives for the science assessment were developed. Included are the sources of the goals and objectives, and the review procedures used to obtain a valid and comprehensive set of goals, objectives, and content areas.

2.1 Distinction Between Goals and Objectives.

For the purposes of the assessment, statements about goals are to be interpreted as expressions about desired dispositions or behaviors of the learner with respect to science. For example, the goal "to develop scientific literacy" is a statement about a desired disposition as an outcome of learning science. Objectives, on the other hand, are statements of what is considered to be acceptable evidence for having achieved one or more of the desired goals. The objective "given a brief explanation of the theory of evolution, the learner will identify examples to illustrate its application" is a statement giving partial evidence for having achieved the goal of scientific literacy. This distinction between goals and objectives is important in considering the results of the assessment program because even if the test items are excellent, the objectives which they represent may not necessarily constitute evidence for the attainment of a desired goal.

2.2 Adoption of Existing Goals and Objectives.

Two major questions in identifying the goals and objectives to be assessed were considered:

1. Do the objectives to be assessed encompass the existing goals of the B.C. science program at the elementary and secondary school levels? A study of B.C. science curriculum materials was undertaken to ensure adequate representation.
2. Do the objectives to be assessed encompass goals important for the future and which should be included in a future curriculum?

Bearing these two major concerns in mind, a search of the literature resulted in the adoption, as a first approximation, of Klopfer's Overall Table of Specifications.¹ (Table 2.1).

The horizontal dimension of the table gives the goals and objectives. The range of goals and objectives encompasses both traditional and modern science programs. It includes, for example, the core curriculum objectives specified by the Ministry of Education and the objectives of programs designed to foster scientific literacy. A major focus of the objectives is on the processes of scientific inquiry which, when

¹ In Bloom, B.S., Hastings, J.T., & Madaus, G.F. Handbook of Formative and Summative Evaluation. New York: McGraw-Hill, 1971. (Ch. 18)

combined with the substantive content of science, constitute scientific paradigms which are the units by which science grows and develops. Other objectives have to do with attitudes toward science and the relationship of science to our culture and the individual.

The vertical dimension of Table 2.1 should encompass the entire range of science content included in traditional and modern science programs at the elementary and secondary school level. The divisions of the content dimension reflect the divisions and subdivisions typically made for pedagogical purposes. The categories are, of course, interrelated. Category 3.0 stresses this feature in that it specifically includes those aspects of science which pertain to all areas of science.

TABLE 2.1

KLOPFER'S OVERALL TABLE OF SPECIFICATIONS

Horizontal Dimension: Instructional Objectives

Objective

Category A.O. Knowledge and Comprehension

- A.1 Knowledge of specific facts
- A.2 Knowledge of scientific terms
- A.3 Knowledge of concepts of science
- A.4 Knowledge of conventions
- A.5 Knowledge of trends and sequences
- A.6 Knowledge of classifications, categories, and criteria
- A.7 Knowledge of scientific techniques and procedures
- A.8 Knowledge of scientific principles and laws
- A.9 Knowledge of theories or major conceptual schemes
- A.10 Identification of knowledge in a new content
- A.11 Translation of knowledge from one symbolic form to another

Category B.O. Processes of Scientific Inquiry I:
Observing and Measuring

- B.1 Observation of objects and phenomena
- B.2 Description of observations using appropriate language
- B.3 Measurement of objects and changes
- B.4 Selection of appropriate measuring instruments
- B.5 Estimation of measurements and recognition of limits in accuracy

Category C.O. Processes of Scientific Inquiry II:
Seeing a Problem and Seeking Ways to Solve it

- C.1 Recognition of a problem
- C.2 Formulation of a working hypothesis
- C.3 Selection of suitable tests of a hypothesis
- C.4 Design of appropriate procedures for performing experiments

TABLE 2.1 (Continued)

Category D.O. Processes of Scientific Inquiry III:
Data and Formulating Generalizations

- D.1 Processing of experimental data
- D.2 Presentation of data in the form of functional relationships
- D.3 Interpretation of experimental data and observations
- D.4 Extrapolation and interpolation
- D.5 Evaluation of a hypothesis under test in the light of data obtained
- D.6 Formulation of generalizations warranted by relationships found

Category E.O. Processes of Scientific Inquiry IV:
Building, Testing, and Revising a Theoretical Model

- E.1 Recognition of the need for a theoretical model
- E.2 Formulation of a theoretical model to accommodate knowledge
- E.3 Specification of relationships satisfied by a model
- E.4 Deduction of new hypotheses from a theoretical model
- E.5 Interpretation and evaluation of tests of a model
- E.6 Formulation of a revised, refined, or extended model

Category F.O. Application of Scientific Knowledge and Methods

- F.1 Application to new problems in the same field of science
- F.2 Application to new problems in a different field of science
- F.3 Application to problems outside of science (including technology)

Category G.O. Manual Skills

- G.1 Development of skills in using common laboratory equipment
- G.2 Performance of common laboratory techniques with care and safety

Category H.O. Attitudes and Interests

- H.1 Manifestation of favorable attitude toward science and scientists
- H.2 Acceptance of scientific inquiry as a way of thought
- H.3 Adoption of "scientific attitudes"
- H.4 Enjoyment of science learning experiences
- H.5 Development of interests in science and science-related activities
- H.6 Development of interest in pursuing a career in science

Category I.O. Orientation

- I.1 Awareness of relationships among various types of statements in science
- I.2 Recognition of the philosophical limitations and influence of scientific inquiry
- I.3 Historical perspective: recognition of the background of science
- I.4 Realization of the relationships among science, technology, and economics
- I.5 Awareness of the social and moral implications of scientific inquiry and its results.

TABLE 2.1 (Continued)

Vertical Dimension: Content

Topic

Category 1.0 Biological Sciences

- 1.1 Biology of the cell
 - 1.11 Cell structure and function
 - 1.12 Transport of cellular material
 - 1.13 Cell metabolism
 - 1.14 Photosynthesis
 - 1.15 Cell responses
 - 1.16 Concept of the gene
- 1.2 Biology of the organism
 - 1.21 Diversity of life
 - 1.22 Regulation in organisms
 - 1.23 Coordination and behavior
 - 1.24 Metabolism in organisms
 - 1.25 Reproduction and development
 - 1.26 Human biology
- 1.3 Biology of populations
 - 1.31 Natural environment
 - 1.32 Cycles in nature
 - 1.33 Natural groups and their segregation
 - 1.34 Population genetics
 - 1.35 Evolution

Category 2.0 Physical Sciences

- 2.1 Chemistry
 - 2.11 Chemical materials
 - 2.12 Classification of chemical elements
 - 2.13 Chemical change
 - 2.14 Chemical laws
 - 2.15 Energy relationships and equilibrium in chemical systems
 - 2.16 Electrochemistry
 - 2.17 Atomic and molecular structure
 - 2.18 Introductory organic chemistry
 - 2.19 Chemistry of life processes
 - 2.110 Nuclear chemistry
- 2.2 Physics
 - 2.21 Kinematics
 - 2.22 Dynamics
 - 2.23 Energy and conservation
 - 2.24 Mechanical advantage
 - 2.25 Mechanics of fluids
 - 2.26 Heat and kinetic theory
 - 2.27 Wave phenomena
 - 2.28 Sound
 - 2.29 Light and spectra
 - 2.210 Static and current electricity
 - 2.211 Magnetism and electromagnetism
 - 2.212 Electronics
 - 2.213 Properties and structure of matter

TABLE 2.1 (Continued)

2.3	<u>Earth and Space Sciences</u>
2.31	Solar system
2.32	Stellar systems
2.33	Meteorology
2.34	Physical geology
2.35	Historical geology
2.36	Geophysics and geochemistry
2.37	Oceanography
2.38	Cosmology
3.0	<u>General</u>
3.1	History of science
3.2	Nature and structure of science
3.3	Nature of scientific inquiry
3.4	Biographies of famous scientists
3.5	Measurement in science

2.3 Adaptation of the Goals and Objectives.

A second approximation to the desired set of goals and objectives was achieved by modifying Klopfer's Table of Specifications as follows:

1. Objectives were subsumed under four overarching goals reflecting current curriculum trends in British Columbia.
2. Some of the objectives were reformulated to bring them more in line with school practices in this province.
3. Both the objectives and the content areas were rated by the Contract Team in terms of priority for assessment purposes at three grade levels, i.e., 4, 8, and 12.

The modified Table of Specifications was submitted to the Management Committee for appraisal. On the basis of the recommendations of the Management Committee, the Contract Team then prepared Tables of Specifications for tests at three grade levels -- i.e., 4, 8, and 12. These tables of Specifications follow.

2.4 Table of Specifications: Grade 4

The Table of Specifications (Table 2.2) shows which objectives were to be given priority in developing and selecting the grade 4 test items. Some of the terms used in Klopfer's Tables were restated in terms felt to be more familiar to educators in British Columbia.

TABLE 2.2
SPECIFICATIONS FOR GRADE 4 TEST

Categories	Objectives	Restated Objectives
A.3	Knowledge of concepts	Understanding concepts
A.5	Knowledge of trends and sequences, classifications, categories, criteria	Recognizing order in nature
B.1	Observation of objects and phenomena	<u>Basic Process Skills:</u> Observing
B.2	Description using appropriate language	Communicating
B.3	Measurement of objects and changes	Measuring
B.4	Selection of appropriate measuring instruments	Measuring
B.6	Classification	Classifying
C.1	Recognition of a problem	<u>Combined Process Skills:</u> Formulating hypotheses
C.2	Formulation of a working hypothesis	Formulating hypotheses
C.3	Selection of suitable tests of hypothesis	Experimenting
C.4	Design of appropriate procedures for experiments	Experimenting/Controlling variables
D.1	Processing experimental data	Experimenting
D.2	Presentation of data in functional form	Interpreting data
D.3	Interpretation of experimental data and observations	Interpreting data
D.4	Extrapolation and interpolation	Interpreting data
D.5,6	Formulation of generalizations and evaluation of hypotheses	Interpreting data/ Formulating hypotheses
F.3	Application to problems outside of science	Applying
G.1	Development of skills in using laboratory equipment	Demonstrating the safe use and care of laboratory equipment.
G.2	Performing common laboratory techniques with care and safety	

The integrated processes or "combined skills": formulating hypotheses, experimenting, interpreting data, and controlling variables, embody the following basic skills:

- observing
- classifying
- measuring
- communicating
- predicting
- inferring
- using space/time relationships

In a well-developed "skills program", the combined skills are often introduced at the primary levels. Evidently then, grade 4 marks a stage when a fair level of mastery of the basic skills can be expected to have been achieved. One emphasis of the grade 4 test, therefore, should be on establishing a baseline for measuring change in competency in the combined skills across grades. A second emphasis should be on checking competency in some of the individual basic skills with a view to identifying possible sources of difficulty in poor performance of the combined skills. A somewhat less important direction to be followed is that of understanding scientific facts, principles, and concepts of science. Concepts in science are constantly changing and are often most precisely expressed in complex theoretical language. The level at which the "big ideas" of science can be taught in the primary grades, compared to the level at which processes of scientific inquiry can be taught, suggests that understanding scientific facts, principles and concepts should be a somewhat secondary objective.

The content areas were also delineated more precisely and brought into line with specific topics taught at the primary levels. The choice of topics given also took into consideration availability of test items for measuring achievement of the objectives given above.

The delineated content areas are given below:

A. Biology

- 1.21 Diversity of plants and animals, classification
- 1.23 Responses of living things
- 1.24 Life processes
- 1.25 Plant and animal development
- 1.31 Natural environment
- 1.32 Food chains, food cycles

B. Chemistry

- 2.11 Chemical materials
- 2.213 Gases, liquids, and solids
 - Metals and non-metals
 - Mixtures and compounds
 - Separating mixtures
 - Analysis of mixtures
- 2.12 Properties of chemical materials

C. Physics

- 2.21 Direction and movement
 - Static and moving objects, space-time relationships
 - Relative motion
- 2.23 Forms of energy, transformation, conservation
- 2.26 Temperature and heat, thermometers, heat transfer
- 2.28 Nature of sound, instruments, pitch, loudness
- 2.29 Light and shadows, reflection, magnification
- 2.210 Simple electric circuits, applications of simple circuits, producing electricity by friction, safety
- 2.211 Magnetism

D. Earth and Space Science

- 2.31 Solar system
- 2.32 Stars, constellations, galaxies
- 2.33 Weather
- 2.35 Our changing earth, geological processes, fossils, dinosaurs

2.5 Table of Specifications: Grade 8

The Table of Specifications shows which objectives were adopted for consideration in the grade 8 achievement tests. Some of the objectives were restated in terms more familiar to grade 8 teachers and the general public.

TABLE 2.3
SPECIFICATIONS FOR GRADE 8 TEST

Categories	Objectives	Restated Objectives
A.3	Knowledge of Concepts	Understanding concepts
A.5	Knowledge of trends and sequences, classifications, categories, criteria	Recognizing order in nature
		<u>Individual Science Inquiry Skills:</u>
A.11	Translation of knowledge from one symbolic form to another	Communicating
B.1	Observation of objects and phenomena	Observing
B.2	Description using appropriate language	Communicating
B.3	Measurement of objects and changes	Measuring
B.4	Selection of appropriate measuring instruments	Measuring
B.5	Estimation of measurements	Measuring
B.6	Classification	Classifying
		<u>Combined Science Inquiry Skills:</u>
C.1	Recognition of a problem	Formulating hypotheses
C.2	Formulation of a working hypothesis	Experimenting
C.3	Selection of suitable tests of hypotheses	Experimenting
C.4	Design of appropriate procedures for experiments	Experimenting/Controlling variables

TABLE 2.3.(Continued)

Categories	Objectives	Restated Objectives
D.1	Processing experimental data	Experimenting
D.2	Presentation of data in functional form	Interpreting data
D.3	Interpretation of experimental data and observations	Interpreting data
D.4	Extrapolation and interpolation	Interpreting data
D.5,6	Formulation of generalizations and evaluation of hypotheses	Interpreting data/ Formulating hypotheses
		<u>Applying Scientific Knowledge and Methods:</u>
F.3	Application to problems outside of science	Transferring scientific ideas and techniques to everyday situations
		<u>Applying Safe Procedures in the Laboratory:</u>
G.1	Development of skills in using laboratory equipment	Using laboratory materials safely
G.2	Performing common laboratory techniques with care and safety	Performing scientific procedures safely
		<u>Scientific Literacy:</u>
I.1	Relationships among various types of statements in science	
I.3	Historical perspective of science	
I.4,5	Relationship of science to other areas of human endeavour	

The major emphasis at the grade 8 level is competency in the combined inquiry skills. A second emphasis at the grade 8 level is the achievement of individual inquiry skills in more complex subject areas.

Two increasingly important features of grade 8 science are achievement in transferring scientific ideas and methods to everyday situations, and the application of safe procedures in working in the laboratory. These are practical concerns which become increasingly important as the student progresses from primary to intermediate and secondary levels of science instruction.

The content areas which were deemed appropriate at the grade 8 level are presented on the next page.

A. Biology

- 1.12 Diffusion and osmosis
- 1.13 Basic ideas of metabolism/respiration
- 1.14 Photosynthesis
- 1.21 Classification of plants and animals
- 1.22,23 Life processes; temperature regulation
- 1.24 Structure and responses of plants and animals
- 1.25 Reproduction in plants and animals
- 1.26 Human ecology
- 1.31 Plant and animal ecology
- 1.32 Food chains, food cycles
- 1.33 Natural groupings
- 1.35 Plant and animal adaption, natural selection

} Ecology

B. Chemistry

- 2.11 Analysis of mixtures and compounds
- 2.12 Properties of chemical materials
- 2.13 Industrial processes, chemical reactions
- 2.17 Elements and compounds, atoms, molecules
- 2.19 Chemistry of respiration, nutrition

} Chemical
properties
and processes

C. Physics

- 2.21 Velocity, acceleration, timing
- 2.23 Forms of energy, mechanical, potential, kinetic
- 2.24 Mechanical advantage of simple machines
- 2.25 Liquid pressure, floating objects
- 2.26 Heat; transfer, change of state, kinetic theory
- 2.28 Sound, pitch, loudness, quality, acoustics
- 2.210 Circuits, electrolysis, applications, (omit Ohm's Law)
- 2.211 Electromagnetic phenomena
- 2.213 Properties of solids, liquids, gases

D. Earth and Space Sciences

- 2.31 Planetary motions, seasons
- 2.32 Sizes and distances of stars
- 2.33 Weather
- 2.34 Rocks and minerals, erosion, weathering, hydrologic cycles
- 2.35 Geological time scale, ice age
- 2.36 Changing of land due to water and ice, energy sources and consumption
- 2.37 Ocean currents, tides, ocean basin, instruments

2.6 Table of Specifications: Grade 12

The table on the following page identifies the objectives adopted for consideration in the grade 12 achievement tests. The objectives were restated in nearly the same way as were the objectives for the grade 8 program.

TABLE 2.4
SPECIFICATIONS FOR GRADE 12 TEST

Categories	Objectives	Restated Objectives
		<u>Knowledge and Comprehension of Science:</u>
A.1	Knowledge of specific facts	
A.3	Knowledge of concepts	
A.5	Knowledge of trends and sequences	
A.6	Knowledge of classification, categories, criteria	
A.7	Knowledge of techniques, procedures	
A.8	Knowledge of principles, laws	
A.9	Knowledge of theories, concepts, schemes	
		<u>Competency in Individual Science Inquiry Skills:</u>
A.11	Translation of knowledge	Communicating
B.1	Observation of objects, phenomena	Observing
B.2	Description of observations	Communicating
B.3	Measurement of objects, changes	Measuring
B.4	Selection of measuring instruments	Measuring
B.5	Estimation, recognition of limits of accuracy	Measuring
B.6	Classifying objects and phenomena	Classifying
		<u>Competency in Combined Science Inquiry Skills:</u>
C.1	Recognition of a problem	Formulating hypotheses
C.2	Formulation of a working hypothesis	Formulating hypotheses
C.3	Selection of tests of hypotheses	Experimenting
C.4	Design of experiments	Experimenting
D.1	Processing data	Experimenting/Controlling variables
D.2	Presentation of data in functional form	Interpreting data
D.3	Interpretation of data	Interpreting data
D.4	Extrapolation, interpolation	Interpreting data
D.5,6	Evaluation & formulating of hypotheses and generalizing	Interpreting data/ Formulating hypotheses
E.1-6	Building, testing, revising theoretical models	Developing models

Table of Specifications: Grade 12 (Continued)

Categories	Objectives	Restated Objectives
		<u>Competency in Applying Scientific Knowledge and Methods:</u>
F.3	Application to problems outside of science	Transferring scientific ideas and techniques to other areas of interest
		<u>Competency in Applying Safe Procedures in the Laboratory:</u>
G.1	Development of skills in using laboratory equipment	Using laboratory materials safely
G.2	Performing common laboratory techniques with care and safety	Performing scientific procedures safely
		<u>Scientific Literacy:</u>
I.1	Relationships among various types of statements in science	
I.3	Historical perspective of science	
I.4	Relationship of science to other areas of human endeavour	

A major emphasis at grade 12 is in the level of achievement attained in the use of combined inquiry skills in more complex areas of science than grade 8 .

Next to the combined inquiry skills, application of scientific ideas and techniques to areas of interest outside of school should be emphasized. Since most secondary school students will probably never become scientists or even complete a degree in science or related fields at university, it was judged important to assess the ability to apply learnings in science to situations in areas of interest other than science.

Scientific literacy, that is understanding science as a worthwhile area of human endeavour and the interrelationship between science and other areas of endeavour in our society, constitutes the third emphasis at the grade 12 level.

Knowledge and comprehension of science was given due attention in the test for purposes of assessing how well the content of science is understood. Much of the content, of course, was subsumed in the items on inquiry skills.

Testing of the individual skills at the grade 12 level was a matter of low priority.

The content areas to be considered at the grade 12 level are:

A. Biology

- 1.12,3,4 Cell physiology
- 1.151 Regulation of cell response
- 1.16 Inherited characteristics
- 1.21 Taxonomic relationships between plants and animals
- 1.22 Metabolism (homeostasis, nutrition)
- 1.23 Response of living things
- 1.25 Animal and plant reproduction
- 1.26 Man as an organism in his environment
- 1.31 Ecology of plants and animals
- 1.32 Food chains and food cycles
- 1.33 Natural groupings
- 1.34 Population genetics
- 1.35 Natural selection

B. Chemistry

- 2.11 Heterogeneous and homogeneous materials
- 2.12 Properties of chemical materials
- 2.13 Chemical laws
- 2.15 Chemical equilibrium, kinetics
- 2.16 Redox reactions
- 2.17 Chemical structure
- 2.18 Chemistry of hydrocarbons
- 2.19 Chemistry of life processes

C. Physics

- 2.21 Velocity, acceleration
- 2.22 Force, inertia, mass, weight
- 2.23 Conservation of energy, momentum
- 2.24 Mechanical advantage, efficiency of simple machines
- 2.25 Hydrostatics
- 2.26 Elementary kinetic theory
- 2.27 Wave phenomena
- 2.28 Principles of acoustics
- 2.29 Spectra, photometry
- 2.210 Principles of electric circuits (D.C.)
- 2.211 Electromagnetic phenomena
- 2.212 Electronics
- 2.213 Structure of matter (molecular systems)

D. Earth and Space Sciences

- 2.31 Kepler's laws
- 2.32 Stellar sizes, distances, motions, composition
- 2.33 Factors controlling weather elements
- 2.34 Physical geology
- 2.35 Historical geology
- 2.36 Energy sources and use

2.7 Appraisal of the Objectives by the Review Panel

Representative panels, one for each level of testing, were constituted in October, 1977 to review the Tables of Specifications together with prototype test items. Specifically, the purposes of the review were to

1. inform the professional and lay public of the purposes to and design of the Science Assessment,
2. provide the teachers and public with the opportunity to contribute their respective ideas as to the emphasis which should constitute the Science Assessment, and
3. enable the participants to examine and critique the range of objectives and sample items for measuring these objectives at the three testing (grade) levels.

The goals and objectives submitted by the Contract Team to the Review Panels for appraisal are given in Tables 2.5, 2.6, and 2.7. The tables also include, for each objective, the median rating of the panel on a 5-point scale. The scale used for rating the objectives was as follows:

- 4 - Maximum priority, urgent need
- 3 - Great importance
- 2 - Probably significant need
- 1 - Possibly significant need
- 0 - Minimum priority

It should be noted that Goal H.0 - Attitudes and Interests in Science, was included in the review at each grade level in order to elicit reaction from members of the panels.

TABLE 2.5
RESULTS OF THE REVIEW--GRADE 4

Goal A.0 - Knowledge and comprehension	<u>Median Rating</u>
Objectives:	
A.3 Understanding concepts of science.	3
A.5,6 Recognizing order in nature.	3
Goal B.0 - Processes of scientific inquiry I (competency in basic process skills)	
Objectives:	
B.1 Observing similarities, differences and changes in physical objects and events.	4

Results of the Review--Grade 4 (Continued)

		<u>Median Rating</u>
B.2	Communicating through appropriate means (diagrams, graphs, numbers, descriptions, etc.), for the understanding of others, the procedures and results of investigating physical objects and events.	4
B.3	Measuring (quantifying) physical objects and events (e.g., force) using arbitrary as well as standardized units (metric).	4
B.4	Measuring physical objects and events using appropriate measuring devices.	3
B.6	Classifying physical objects and events into logical groupings.	4
Goals C.0, D.0 - Processes of scientific inquiry II and III (competency in combined process skills)		
Objectives:		
C.1,2	Recognizing the problem and formulating working hypotheses to be investigated.	2
C.3	Recognizing appropriate ways of testing hypotheses.	2
C.4	Designing appropriate experimental procedures for testing hypotheses.	2
D.1	Processing experimental data in appropriate ways (e.g., averaging instead of summing).	2
D.2	Presenting data in functional form (e.g., $d = vt$).	2
D.3	Interpreting experimental data and observations.	3
D.4	Extrapolating and interpolating data.	3
D.6	Formulating generalizations appropriate to the data.	3
Goal F.0 - Application of scientific knowledge		
Objectives:		
F.3	Applying scientific facts and principles to problems outside of science.	3
Goal G.0 - Safety in performing manual skills		
Objectives:		
G.1	Developing skill in using common laboratory equipment with safety.	4
G.2	Performing common laboratory techniques with care and safety.	3

Results of the Review--Grade 4 (Continued)

Median
Rating

Goal H.0 - Attitudes and interests in science

Objectives:

H.1	Enjoying science learning experiences.	4
H.5	Developing an interest in science and science-related areas.	4
H.6	Developing an interest in pursuing a career in science.	0

Goal I.0 - Scientific literacy

Objectives:

I.3	Awareness of the historical development of science.	1
I.4	Recognizing relationships among science, technology, and economics.	2
I.5	Awareness of the social and moral implications of scientific inquiry and its results.	2

TABLE 2.6
RESULTS OF THE REVIEW--GRADE 8

Goal A.0 - Knowledge and comprehension

Median
Rating

Objectives:

A.3	Understanding concepts of science.	3
A.5,6	Recognizing order in nature.	3

Goal B.0 - Process of scientific inquiry I (competency in basic process skills)

Objectives:

A.11	Translating knowledge from one symbolic form to another.	3
B.5	Measuring (estimating).	4
B.6	Classifying physical objects and events into logical groupings.	3

Goals C.0, D.0 - Processes of scientific inquiry II and III (competency in combined process skills)

Objectives:

C.1,2	Recognizing the problem and formulating working hypotheses to be investigated.	3
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Results of the Review--Grade 8 (Continued)

		<u>Median Rating</u>
C.3	Recognizing appropriate ways of testing hypotheses.	3
C.4	Designing appropriate experimental procedures for testing hypotheses.	3
D.1	Processing experimental data in appropriate ways (e.g., averaging instead of summing).	3
D.2	Presenting data in functional form (e.g., $d = vt$).	1
D.3	Interpreting experimental data and observations.	2
D.4	Extrapolating and interpolating data.	3
D.5,6	Formulating generalizations and evaluating hypotheses.	3
Goal F.0 - Application of scientific knowledge		
Objectives:		
F.3	Applying scientific facts and principles to problems outside of science.	4
Goal G.0 - Safety in performing manual skills		
Objectives:		
G.1	Developing skill in using common laboratory equipment with safety.	2
G.2	Performing common laboratory techniques with care and safety.	2
Goal H.0 - Attitudes and interests in science		
Objectives:		
H.1	Enjoying science learning experiences.	2
H.5	Developing an interest in science and science-related areas.	3
H.6	Developing an interest in pursuing a career in science.	1
Goal I.0 - Scientific literacy		
Objectives:		
I.3	Awareness of the historical development of science.	1
I.4	Recognizing relationships among science, technology and economics.	3
I.5	Awareness of the social and moral implications of scientific inquiry and its results.	4

TABLE 2.7
RESULTS OF THE REVIEW--GRADE 12

Goal A.0 - Knowledge and comprehension		Median Rating
Objectives:		
A.1	Knowledge of specific facts.	2
A.3	Understanding concepts of science.	3
A.5,6	Recognizing order in nature.	3
A.7	Knowledge of techniques, procedures.	3
A.8	Knowledge of principles, laws.	3
A.9	Knowledge of theories, concepts, schemes.	2/3
Goal B.0 - Processes of scientific inquiry I (competency in basic process skills)		
Objectives:		
B.1	Observing similarities, differences, and changes in physical objects and events.	4
B.2	Communicating through appropriate means (diagrams, graphs, numbers, descriptions, etc.), for the understanding of others, the procedures and results of investigating physical objects and events.	4
B.3	Measuring (quantifying) physical objects and events (e.g., force) using arbitrary as well as standardized units (metric).	3
B.4	Measuring physical objects and events using appropriate measuring devices.	3
B.5	Measuring, estimating and recognizing limits of accuracy.	2
B.6	Classifying physical objects and events into logical groupings.	3
Goals C.0, D.0, E.0 - Processes of scientific inquiry II and III (competency in combined process skills)		
Objectives:		
C.1,2	Recognizing the problem and formulating working hypotheses to be investigated.	4
C.3	Recognizing appropriate ways of testing hypotheses.	3
C.4	Designing appropriate experimental procedures for testing hypotheses.	3

Results of the Review--Grade 12 (Continued)

		<u>Median Rating</u>
D.1	Processing experimental data in appropriate ways (e.g., averaging instead of summing).	3
D.2	Presenting data in functional form (e.g., $d = vt$).	2
D.3	Interpreting experimental data and observations.	4
D.4	Extrapolating and interpolating data.	3
D.5,6	Formulating generalizations and evaluating hypotheses.	3
E.1-6	Building, testing, revising theoretical models.	2
Goal F.0 - Application of scientific knowledge		
Objectives:		
F.3	Applying scientific facts and principles to problems outside of science.	4
Goal G.0 - Safety in performing manual skills		
Objectives:		
G.1	Developing skill in using common laboratory equipment with safety.	2
G.2	Performing common laboratory techniques with care and safety.	2
Goal H.0 - Attitudes and interests in science		
Objectives:		
H.1	Enjoying science learning experiences.	3
H.5	Developing an interest in science and science-related areas.	3
H.6	Developing an interest in pursuing a career in science.	2
Goal I.0 - Scientific literacy		
Objectives:		
I.3	Awareness of the historical development of science.	3
I.4	Recognizing relationships among science, technology, and economics.	4
I.5	Awareness of the social and moral implications of scientific inquiry and its results.	4

The review resulted in a few minor changes in the tables of specifications. One major concern was for the lack of relevance to everyday life in the prototype items presented. The Panels felt that too narrow an academic view of science was being presented. They called for a wider interpretation of the application goal to include not only the ability to apply scientific concepts to novel situations, but also the knowledge of various everyday or practical applications of science. Another request was to include, under the scientific literacy goal, the ability to read and interpret passages dealing with science-related issues such as might be found in magazines. The Contract Team took these recommendations into account by supplementing the item bank where necessary, and preparing a new version of the list of goals.

2.8 Final Version of Goals

GOAL 1

Understanding Concepts, which includes

the knowledge and comprehension of important models, generalizations, theories, principles, ideas and concepts of science, such as the principles of electrical circuits, the concept of biological variation, the structure of atoms, or the processes of mountain formation.

Example¹ of an item used to test understanding concepts:

Green plants are important to animals because the plants	<u>p-values</u>	
	<u>Gr.8</u>	<u>Gr.12</u>
a) consume both food and oxygen	16	5
b) consume food and give off oxygen	15	6
c) consume food and give off carbon dioxide	7	3
*d) produce food and give off oxygen	43	66
e) produce food and give off carbon dioxide	12	16
f) I don't know	6	4

¹Results shown for this, and other examples in this chapter, indicate the correct answer (*); the percent of students responding to each response option (p-value); and the grade levels at which items were tested.

GOAL 2

Skill in the Processes of Science, which includes

- observing (carefully noting the characteristics or properties of things or the sequence of events),
- classifying (grouping things according to shared characteristics or properties),
- communicating (reporting observations and conclusions in appropriate ways, interpreting information which has been communicated in a scientific way),
- measuring (understanding units of measurement, choosing appropriate measuring instruments, using measuring instruments correctly),
- combined skills (designing experiments, controlling variables, interpreting data).

Example of an item used to test classifying:

Look at these pictures of imaginary pond water animals

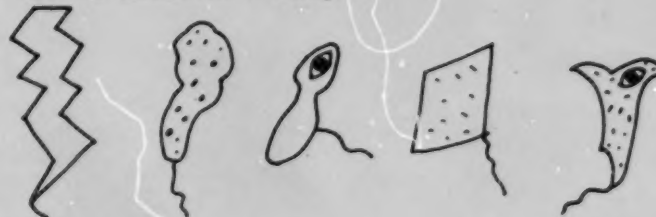
ALL of these are Plaps:



NONE of these is a Plap:



Which one of these is a Plap?



A B C D E

	p-values	
	Gr.4	Gr.8
A.....	8	3
B.....	9	9
C.....	15	7
D.....	3	2
*E.....	60	33
I don't know...	4	11

Example of an item used to test measuring:

Which would be easiest to measure with a metric ruler that is 30 cm long?	
	<u>p-values</u> <u>Grade 4</u>
*a) the length of a pencil	69
b) the thickness of a sheet of paper	16
c) the distance from your home to the school	3
d) the distance from your home to the nearest grocery store	2
e) I don't know	9

Example of an item to test combined skills:

Mary and Dave each bought the same kind of rubber ball. Mary said, "My ball bounces better than yours." Dave replied, "I'd like to see you prove that." What should Mary do?	
	<u>p-values</u> <u>Grade 4</u>
*a) Drop both balls from the same height and see which bounces higher.	67
b) Throw both balls against the wall and see how far each ball bounces off the wall.	3
c) Drop the two balls from different heights and see which bounces higher.	3
d) Throw the balls down against the floor and see how high they bounce.	14
e) Feel the balls by hand to find which is harder.	10
f) I don't know.	2

GOAL 3

Application, which includes

the ability to apply scientific knowledge to given problems and the knowledge of the way in which scientific principles are applied in the practical world.

Examples of application items:

Fanning can make a campfire burn better because the fanning	<u>p-values</u> <u>Grade 8</u>
a) raises the atmospheric pressure.	3
b) warms materials to their kindling points.	2
c) increases the supply of material that can burn.	3
*d) increases the supply of oxygen for the burning.	<u>81</u>
e) provides the energy needed to keep the fire going.	8
f) I don't know.	2
Which makes use of the magnetic lines of force around an electric current?	<u>p-values</u> <u>Grade 12</u>
a) A compass	16
b) A dry cell	26
c) A storage battery	9
d) An electric toaster	5
*e) A telephone receiver	<u>16</u>
f) I don't know	28
Scientists are skeptical that Earth has been visited by beings from outside the solar system because	<u>p-values</u> <u>Grade 12</u>
a) there is no life anywhere in the Universe except on Earth.	4
*b) the distances between stars are enormous.	<u>36</u>
c) only crackpots believe in such nonsense.	4
d) few places outside the solar system can support life.	48
e) I don't know	6

GOAL 4

Safety, which includes

the knowledge of safe procedures and precautions in the use of hazardous materials and equipment in the laboratory, the classroom, or the home.

Example of a safety item at the grade twelve level:

Which of the following substances must be kept away from sparks or open flames?	<u>p-values</u> <u>Grade 12</u>
a) Hydrochloric and sulfuric acid	18
b) Sodium hydroxide and potassium hydroxide	15
*c) Alcohol and ether	<u>61</u>
d) Tin and lead	2
e) I don't know	4

GOAL 5

Scientific literacy, which includes

understanding and appreciation of the nature of science and its methods, and the ability to interpret discussion of science-related issues.

Examples of scientific literacy items:

About what topic do scientists know everything?	<u>Gr.4</u>	<u>p-values</u> <u>Gr.8</u>	<u>Gr.12</u>
a) Clouds	9	7	3
b) Stars	29	13	3
c) Trees	32	11	5
*d) No topic	<u>24</u>	<u>64</u>	<u>84</u>
e) I don't know	5	5	5
In discussing the problem of nuclear proliferation, a famous scientist declared that Canada must provide more Candu reactors for developing countries. What is the best evaluation we can give to this scientist's statement?			
a) His conclusion is probably right, since he approaches the problem with a scientific attitude.			4
b) His conclusion is probably wrong, because scientists seem to be trying to destroy the world.			5
c) His conclusion and reasons are probably correct, because scientific results are the most reliable kind.			8
*d) His conclusion and reasons should be weighed according to his knowledge of international affairs.			<u>58</u>
e) I don't know			21

GOAL 6

Favourable Attitudes to Science and Scientists, such as

favourable attitudes to scientists as people, and towards science as a school subject, as a career, and, as an interest.

The attitude instrument included statements as shown in these four examples in which the students expressed a degree of agreement or disagreement¹ with the given statement:

Scientific facts are usually true	1 2 3 4 5
Scientific ideas can usually be proven by experiment	1 2 3 4 5
Scientific ideas are usually too difficult to understand for most ordinary people	1 2 3 4 5
Most scientific ideas of long ago are out-of-date because they are wrong	1 2 3 4 5

Other types of attitude items were queries to the students about how frequently² they did certain things, as shown in these examples:

Talked to someone in school about things that interest me in science	1 2 3 4 5
Tried to find out how some of the major industries in B.C. such as fishing, lumbering, and mining, apply scientific ideas	1 2 3 4 5
Successfully carried out a scientific experiment which I designed myself.....	1 2 3 4 5

¹

1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree
5 = Strongly Agree

²

1 = Never, 2 = Rarely (once or twice), 3 = A Few Times,
4 = Quite Frequently, 5 = Very Frequently

CHAPTER 3
TECHNICAL DETAILS

3.1 The Achievement Tests

The goals described in Chapter 2 encompass a potentially enormous number of possible learning objectives -- far too many at any one level for a single test. Obviously, the tests would be able to cover only a small sample of all the possible objectives. Faced with the problem of selecting this sample of objectives, and with the concern to select good test items, the Contract Team proceeded in the following way:

A bank of multiple-choice test items was established, drawn from the following sources:

- National Assessment of Educational Progress, released items 1969-70 and 1972-73.
- International Association for the Evaluation of Educational Achievement Six Subject Survey.
- Process Achievement Test
- Test of Science Processes
- Test on Understanding Science
- Cooperative Science Tests
- STEP Science Tests
- Dunning-Abeles Physics Test
- Dubin's Earth Science Test
- Processes of Science Test
- A Test of Aspects of Scientific Thinking (Burmester)
- Science--A Process Approach materials.

Each item in the bank was classified according to goal, content area, and grade level. Where there were insufficient items for a grade in a given goal-content category, items were constructed by the Contract Team to fill the gap.

Items were then selected from the bank to form three sub-banks, one for each of grades 4, 8, and 12. Selection was made on the basis of apparent quality of items and suitability to the British Columbia situation within the constraint of maintaining balance among goals and content areas. In effect each sub-bank represented a sampling of objectives from the large number of possible objectives encompassed by the goals.

Since the item bank was built from diverse sources, the items varied in response choice format. Some items had four response choices, some had five. Some items, including those from the United States National Assessment, included the option "I don't know."

In order to maintain as much comparability as possible with results of with other data such as that from the National Assessment, the response formats of the items were left unchanged, except for the addition of the "I don't know" option.

Use of the "I don't know" option is consistent with previous provincial assessments.

The grades 4, 8, and 12 sub-banks initially contained 81 items, 129 items and 196 items respectively. These items were grouped to form two pilot tests at each grade level. The pilot tests were administered to 351 grade four, 505 grade eight, and 460 grade twelve students. The students were enrolled in schools selected by the Ministry of Education to be reasonably representative of the province. Students were tested in their usual class groups (English classes at grade twelve).

Item analysis of the pilot results was used to locate items which might be unsuitable. If an item had a negative biserial correlation coefficient with the other items in a given goal or objective, it was rejected. Some items with low positive biserials were retained if they seemed to have face validity with respect to the goal, because the goals were wide categories, and relatively few items could be included for any one goal or objective. Items which had very high or low difficulty were re-examined for possible problems in wording, but since the tests were to be objective referenced, such items were not automatically eliminated.

On the basis of the item analysis and consultation with the Management Committee, 68 items were selected for the grade 4 test, 92 for the grade 8 test, and 120 for the grade 12 test. The grades 8 and 12 tests were each split into two separate booklets, so that one test booklet could be administered in a one-hour period. Teachers were instructed to issue alternate booklets to alternate students. The two booklets were designed to be roughly equivalent in difficulty and in the objectives covered.

Much concern was expressed by members of the Review Panels that poor readers would have excessive difficulty with the written multiple-choice test in grade four, causing systematic attenuation of the scores. Experimental work was undertaken by the Contract Team, as part of the pilot testing program, to investigate this potential problem. The results showed that performance on most items increased when the questions, but not the answer choices, were read aloud to the children by their teacher.¹

¹ In the experiment, approximately 200 grade 4 students from three schools were randomly assigned to three treatment conditions. In one group, students read the questions for themselves. In a second group, the entire test was read to the students via a tape recording. In the third group, teachers read the item stems, but not the response choices, to their students.

For 18 percent of the items, more than 10 percent of the students showed an increase in correct responses. Accordingly, teachers were instructed to read the question stems but not the response choices to their grade four classes as they took the test.

Grade four students responded to the items by placing marks in boxes in the question booklets. Grades 8 and 12 students responded on specially designed OMR cards which were machine scored. In addition, the grade four test was printed in two sections so that teachers could administer the test in two sittings. All tests in their final form are reproduced in Appendix A, together with a summary of results for each item.

3.2 Measuring Interests and Attitudes Toward Science

In common usage the words "interests" and "attitudes" cover such a wide range of human attributes that precise measurement is impossible. Krathwohl tried to set down some guidelines for using these terms in the Taxonomy of Educational Objectives: Affective Domain.¹ Unfortunately, the problem of measuring achievement of these objectives in reliable and valid ways received much less attention.

Social psychologists, long before the Taxonomy, tried to delineate attitude and measure it precisely. The failure of this endeavor to predict behaviour on the basis of the attitude alone is worthy of note because, in spite of the failure, the myth that behaviour and measured attitude are closely connected lingers on among educators. It does not follow, just because there has been a change in a certain direction of interest or attitude toward something, that behaviour will change in the same direction or even change at all. Predicting behaviour from attitude turns out to be far more complex than had been anticipated. In spite of these difficulties, a survey of student attitudes was considered to be of sufficient importance to warrant inclusion as an integral component of this assessment.

3.2.1 Description of the Terms, "Interest" and "Attitude"

Interest - Educational objectives in the "responding" category, according to Krathwohl, 1969, p. 178, which stress enjoyment of certain activities as a student response to instruction, are classified under "interests". Operationally, willingness to respond in some definite way and voluntary involvement in certain activities were used as indices of interest for the present assessment.

Attitude - Thurstone's definition of attitude as a learned pre-disposition to respond toward an attitude object in a favorable or unfavorable way was used in the assessment in preference to Krathwohl's description of attitude in terms of "valuing" (p. 178). Thurstone's definition has the advantage that there are a number of ways of measuring attitude based on this notion, while no well-established techniques for measuring attitude based on Krathwohl's description exist.

¹ Krathwohl, D.R., Bloom, B.S., & Masia, B.B. Taxonomy of Educational Objectives: Affective Domain. New York: McKay, 1964.

3.2.2 Goal 6: Interests and Attitudes Towards Science

Chapter 2 described the interests and attitudes goal in some detail. Briefly, the specific objectives to be assessed fall into the following six categories:

- H.1 Attitude toward science and scientists
- H.2 Acceptance of scientific inquiry as a mode of thought
- H.3 Adoption of scientific attitudes
- H.4 Enjoyment of science learning experiences
- H.5 Development of interests in science and science-oriented activities
- H.6 Development of an interest in pursuing a career in science

3.2.3 Development of the Instrument

In order to assess achievement of these objectives, a special instrument was developed (see Appendix). The instrument has five parts, A, B, C, D, and E, which relate directly to interests and attitudes. Part F stands alone and was included as a convenience for cross-checking data from the teacher survey. It includes questions similar to some of the items on the teacher questionnaires relating to instructional practices in science. Parts A - E are as follows:

- Part A - Attitude Scales: Based on evaluations of attitude objects
- Part B - Interest Scale: Willingness to engage in science-related activities
- Part C - Interest Scale: Voluntary involvement in science-related activities
- Part D,E - Attitude Scales: Based on belief statements about science-related attitude objects

The attitude scales in Part A are of the semantic-differential type. The attitude objects were "scientists", "science", "doing science experiments", "science I have taken in school", "reading books about science" and, for reference purposes, "industrialist" and "school". The student was required to indicate the strength of association of the attitude objects with adjectives anchoring the ends of 7-point bipolar scales. The bipolar adjectives used for the scales were those previously found to have high validity and reliability for measuring attitude.

The interest scales, Parts B and C, were developed from a list of advocated science-related activities obtained from students, teachers, science texts, science magazines, and various writings about science teaching. The activities are presented in statement form for rating on two different kinds of scales. Part B of the scale used is based on personal hypothetical action, i.e., probability of willingness to respond. In Part C, the scale used is based on personal action, i.e., frequency of voluntary involvement in the specified activities during the present school year. In this way, two levels of response, approximating actual observed behaviour, were used to assess interest in science-related activities. The item responses to Parts B and C were analyzed and reported item by item (see Chapter 4). They were to be interpreted in the same way as responses to questions on a descriptive survey, i.e., percent responses on each interval of the scale for each item, having due regard for precision of measurement.

Parts D and E consist of belief statements about attitude objects such as science as a career, scientists, and the nature of science. Ten carefully selected belief statements for each attitude object were obtained from discussions with students, teachers, and from various writings in science education.

A 5-point scale was used to get a measure of the intensity of students' belief of each of the statements given. The usual strongly agree - strongly disagree scale was used for this purpose. The weights given to the various intervals of the scale range from 5 for strongly agree to 1 for strongly disagree. A weight of +1 was given to a statement if it also reflected a positive attitude (favorableness) toward the attitude object, or a -1 if it reflected a negative attitude (unfavorableness). By summing the products of the attitude weights and belief weights for each statement about an attitude object, an attitude score for the attitude object was obtained.

3.2.4 Pilot-Study of the Instrument

The entire instrument, Parts A-E, was administered in February, 1978 as follows:

<u>Grade</u>	<u>Number of Schools</u>	<u>Number of Classes</u>	<u>Number of Students</u>
7	6	8	210
9	5	8	180
11	4	8	171

The results showed that about 35 minutes were needed to complete the instrument and that some of the directions and some of the wording needed to be simplified. This was done and subsequently the final draft was prepared. Routine item analysis indicated acceptable internal consistency of the various scales, except for the two scales 9 and 10 in Part E where unacceptable, low reliability coefficients were found (i.e., 0.42 and 0.50 for "scientists" and "science" respectively), precluding their use as summative rating scales. Therefore, the results for each of the statements in Part E were merely interpreted in the same way as responses to questions on a descriptive survey or "opinion poll".

3.3 Sampling Procedures

3.3.1 Achievement Tests

The achievement tests were administered to all students in grades 4, 8, and 12 who were attending school on the day selected by the principal (in the week of March 13 to 17). At the grade 8 and 12 levels Parts A and B were randomly distributed to the class by the teacher so that one half of the class completed each part.

3.3.2 Attitude Survey

The student attitude survey was given to a sample of grade 7, 9 and 11 students. The sample size for this survey was 5 percent of the total student population at the grade 7 and 9 levels, and 10 percent of the grade 11 population (plus an additional over-sampling of 10 percent of the sample to cover non-returns). A larger sample was required at the grade 11 level to enable comparisons between those students who elected to take one or more senior science courses and those grade 11 students who had not yet taken any science courses beyond the grade 10 level. The sampling unit was the classroom and the sample was drawn by B. C. Research to ensure proportional zone representation for the Province and representation of different sizes of school. For those schools selected by this technique, the principals were given a procedure to ensure a random selection from the english class(es) in the school for the grade 11 students, the general science classes for grade 9 students, and regular grade 7 classes for the grade 7 students.

3.3.3 Teacher Questionnaires

Teachers at all grade levels were selected to receive one of the three types of teacher questionnaires prepared for the elementary, junior-secondary and senior-secondary grade levels. The September 1977, Form J was used to determine which elementary grades and secondary subjects were taught by each teacher. Nineteen categories were used to determine eligible teachers. These categories were: the kindergarten through grade 7 teachers (8 categories); the grade 8 through grade 10 science teachers (3 categories); and the biology, chemistry, physics and earth science teachers at the grades 11 and 12 levels (8 categories). Many teachers were thus considered under more than one category, but each teacher was randomly assigned to one of the categories for which they qualified and instructed to respond to the questionnaire as a teacher of that particular grade level or subject area.

The elementary teachers were randomly sorted into one of the grade categories in which they qualified. A list of teachers was prepared in each grade category for each regional zone. The procedure to sample from each of these lists consisted of selecting at random a number between 1 and 5 to decide the first teacher, and thereafter, selecting every 5th teacher to arrive at a 20 percent sample, proportional to zones.

A random procedure was used to assign secondary science teachers to one of the available 11 categories. Once this assignment was completed, all teachers from each of these categories were surveyed. The questionnaire, and the teachers were asked to respond as a teacher of "Grade 9, Science", "Grade 11 Chemistry", etc.

The numbers of questionnaires sent out using these sampling procedures were:

elementary	2,542
junior secondary	1,090
senior secondary	510
total	4,142

3.4 The Interpretation Process

Interpretation of results of achievement tests presents a complex problem. In the B. C. Learning Assessment Program the approach has been to convene panels of educators and lay persons to discuss the results and interpret their meaning.

Three Interpretation Panels were established by the Ministry of Education -- one for each of the grades tested. A list of members of the Interpretation Panels is given in the Summary Report, Appendices, page 54.

The procedures for the interpretation were similar to those used in the British Columbia Mathematics Assessment of 1977.

A representative group of panelists was selected for each of the three grade levels. In preparation for the panel sessions, the panelists were asked to complete several tasks before meeting as a group. First they were requested to go through the test for the grade level at which they would be responding and to select the best answer for each question. Second, they reviewed the booklet entitled "Organization of Test Items" which categorized the test items according to goals and objectives. Third, they established two levels of performance for each item: An "acceptable level of performance" to represent the minimum percent of students who must respond correctly before the panelist would be satisfied with provincial performance on that item; and a "desired performance level" to indicate the percent of students who must have responded correctly before the performance would have been considered a strength.

When the panelists convened for the meetings on the evening of June 11, 1978 they were given the obtained 'p-value' (percent of students in the province who responded correctly) for each of the items on the test for their particular grade level. They were asked to compare the obtained p-value with their previously established acceptable and desired level of performance and then to rate each item on five point scale ranging from strength to weakness. The next step was to form into pairs, with each pair of panelists discussing their ratings for every item to arrive at consensus. The panelists then met as a group to discuss each item and to attempt to arrive at a group consensus. This procedure involved considerable group discussion for many of the items, and required a full day.

The final task for the panelists was to make judgments regarding student performance on each of the goals. This was done by dividing the panel members into groups to examine the consensus ratings assigned to each of the items in a given goal area. The intent was to summarize and interpret the identified strengths and weaknesses for each goal, and to make comments regarding performance on the goal. Each group's agreement was reached by the panel, but minority opinions were recorded. Panel ratings and interpretations are given in Chapter 4.

CHAPTER 4

RESULTS

4.1 Achievement: Grade 4

4.1.1 Priority of Goals Assessed

On the basis of the recommendations made by the Management Committee and the Review Panel, the main emphasis in the grade 4 test was on (1) understanding concepts, and (2) basic processes (classifying, observing, communicating, and measuring). Lesser emphasis was placed on combined process skills, application, and safety. Four items on scientific literacy were included, solely to provide comparative data for the grades 8 and 12 tests.

The distribution of items was

understanding concepts	- 26
basic processes	- 23
combined skills	- 5
application	- 5
safety	- 5
scientific literacy	- 4

4.1.2 Description of the Test and Administration Procedures

Because of its length (68 items), the test was split into two parts with instructions that both parts be done on the same day but in separate sittings, with a rest period in between (e.g. recess or lunch). The time allocation for Part 1 of the test was 45 minutes (which included time for distributing the booklets and completing background information questions), and for Part 2, 35 minutes.

From the beginning, the Contract Team was concerned about testing scientific knowledge and skills at grade 4 using a multiple choice format because this would involve a considerable amount of reading for students. When it became clear that alternative techniques for data collection, such as individual or small group interviewing, would not be feasible, a more careful examination of the possible effects of reading upon test results was initiated. The first step was to submit the items which were to be pilot tested to a reading specialist who identified words not on the grade four core vocabulary list, and potentially difficult sentence structures in the stems. The second step was to carry out a controlled experiment using three different methods of administering the test: one group of students read the entire test for themselves, a second group had the stems of the questions read to them by their teacher but read the response choices for themselves. A third group listened to a pre-recorded audiotape which read all items for the students and controlled the pace at which they responded to the questions. The three groups were randomly selected from a sample of 161 students from four schools in the Vancouver and Burnaby school districts. The results of this experiment indicated that in general the group using the pre-recorded audiotape performed better than the group for which the teacher read the stems only, and this group in turn performed better than the group which read the test for themselves.

The differences between the audiotape group and the teacher-read group were not considered to be large enough to warrant the expense and inconvenience of supplying pre-recorded cassette tapes to all in the province. Hence, the decision was made by the Contract Team and Management Committee to have the teachers read the stem part of the questions only to their classes. Teachers were instructed not to read the foils so as to prevent any unconscious emphasis on the correct answer. The instructions which were provided to teachers are reproduced in Appendix F.

The only background information obtained from the grade 4 students was age and sex. Earlier assessments have gathered sufficient information on such students' characteristics such as television viewing, language, and number of schools attended, and that there seemed no valid reasons to suggest any of these characteristics would influence science achievement in ways different from that reported in previous assessments.

4.1.3 Description of the Population

The test was to be given to all students "in grade 4 or its equivalent". School principals were instructed to use their own discretion with regard to "atypical (special education) children". However, they were asked "to include as many of these children as possible for the assessment".

A total of 35,087 students wrote Part 1 of the test and 35,302 students wrote Part 2. This represents 95.2% of the total grade four population reported on Form B in February 1978.

Table 4.1 provides the breakdown by age and by sex of the students who wrote Part 1 of the grade 4 test.

TABLE 4.1
AGE AND SEX OF GRADE 4 STUDENTS

	Age 12 or older	Age 11	Age 10	Age 9	Age 8 or younger	TOTAL
Male	107	746	5,693	11,296	136	17,978
Female	71	378	4,476	12,045	139	17,109
TOTAL	178	1,124	10,169	23,341	275	35,087

4.1.4 Test Results

The achievement test items covered five goals. The results for each goal are discussed below. Each section contains information on the results actually obtained by the students, the ratings of the Interpretation Panel and a brief discussion of the results for that goal.

4.1.4.1 Understanding Concepts

The scores reported in Table 4.2 are the percent of correct responses for each of the 26 items which were used to assess the goal of understanding concepts, together with the ratings of the Interpretation Panel.

TABLE 4.2
RESULTS ON UNDERSTANDING CONCEPTS: GRADE 4

Item Number	Panel Rating	Percent Correct			Description of Items ¹
		Male	Female	Total	
1	Strength	91	88	90	Floating objects
2	Satisfactory	77	70	74	Revolution of Earth around Sun
5	Marginal	42	27	35	Principle of gravitation
7	Marginal	33	28	31	Calculation of speed
8	Weak	56	56	56	Temperature of seasons
14	Satisfactory	49	40	45	Succession of life forms on Earth
15	Satisfactory	53	48	51	Balancing on a teeter-totter
16	Very Satisfactory	84	83	84	Conditions for snow
19	Marginal	24	18	21	Recovering dissolved salt
23	Marginal	48	47	47	Solubility of common substances
24	Very Satisfactory	85	86	86	Life history of butterfly
26	Satisfactory	44	39	42	Action of germs
30	Strength	90	82	86	Fossilization
34	Strength	95	96	96	Signs of sickness in dog
36	Very Satisfactory	74	71	73	Conditions for evaporation
38	Marginal	51	52	51	Where seeds come from
41	Satisfactory	68	63	65	Function of lungs
42	Satisfactory	53	51	52	Effect of temperature change on balloon
47	Satisfactory	76	49	63	Arrangement of batteries in a flashlight
48	Very Satisfactory	81	78	79	Conditions for rusting
49	Marginal	20	16	18	Unequal arm balance
50	Strength	95	96	96	Conditions for rainbow
51	Very Satisfactory	86	81	84	Concept of speed
54	Very Satisfactory	42	46	44	Inversion of mirror image
63	Weak	45	41	43	Celsius temperature
68	Very Satisfactory	87	86	87	Conditions for rain

In general the performance of the grade 4 students on understanding concepts can be considered as very acceptable.

The Interpretation Panel rated 18 of the 26 items as satisfactory or better, six as marginal, and only two as weak. Both items judged to be weak involved temperature on the celsius scale, as in the following example:

¹

Items are given in full in the Appendix

8. In many parts of British Columbia a noon temperature of 2°C is most likely in

	p-values Grade 4
*a) January	56
b) May	13
c) June	12
d) July	11
e) I don't know	8

Teachers should ensure that ample time is provided for working with celsius thermometers. A suitable daily or weekly routine would be recording and charting the outside temperature. Pupils could also be given opportunities to measure the temperatures of various hot and cold objects.

The marginal performance on item 38 (which part of a plant do seeds come from?) is surprising, especially considering the usual emphasis in the primary grades on seeds and plants. Thirty-two percent of the pupils thought that seeds come from the roots of plants, and only 51 percent chose "flower" as the correct answer. Perhaps this indicates that many children study plants in a series of isolated instances without the opportunity to observe the entire life cycle of a plant and to see where the seeds are produced.

4.1.4.2 Processes of Science

Results are reported separately for each of five process objectives in Table 4.3 below.

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
4	Very Satisfactory	72	75	73	Recognize attributes of class from instances and non-instances
6	Strength	95	95	95	Classify things as living or non-living
40	Very Satisfactory	74	76	75	Recognize attributes of class from instances and non-instances
45	Strength	91	92	92	Recognize basis for classification
61	Very Satisfactory	59	64	62	Recognize attributes of two-way classification

Results on Processes: Grade 4 (Continued)

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
OBSERVING					
11	Strength	98	99	98	Read simple bar graph
12	Strength	98	98	98	Read simple bar graph
18	Very Satisfactory	80	79	80	Recognize appropriate statements of observations
31	Strength	94	96	95	Match identical shapes
56	Strength	90	90	90	Observe relative position of two objects
COMMUNICATING					
9	Very Satisfactory	80	81	81	Match statements with bar graph
27	Very Satisfactory	79	80	80	Interpret sequence of symbols using key
28	Very Satisfactory	41	41	41	Interpret sequence of symbols using key
55	Satisfactory	57	61	59	Describe change
66	Satisfactory	65	60	63	Match statements of data with graph
67	Strength	96	96	96	Select correct interpretation of graph
MEASURING					
3	Satisfactory	71	70	71	Estimate length in cm
13	Satisfactory	69	74	71	Recognize need for initial reading to measure change
25	Satisfactory	80	75	78	Recognize metre as unit of length
33	Satisfactory	83	81	82	Actual measurement with ruler
37	Very Satisfactory	81	76	78	Volume by displacement
44	Marginal	68	61	65	Recognize kilogram as unit of mass
59	Satisfactory	43	37	40	Select appropriate container to measure rainfall
COMBINED SKILLS					
17	Strength	92	90	91	Problem solving
29	Strength	78	81	79	Interpreting data
32	Satisfactory	61	62	62	Controlling variables
52	Very Satisfactory	62	70	66	Testing hypothesis
58	Very Satisfactory	71	62	67	Designing experiment

The results for processes are very encouraging on all five objectives. The Interpretation Panel rated performance on only one of the 28 items as less than satisfactory, and that item was in effect a knowledge item,

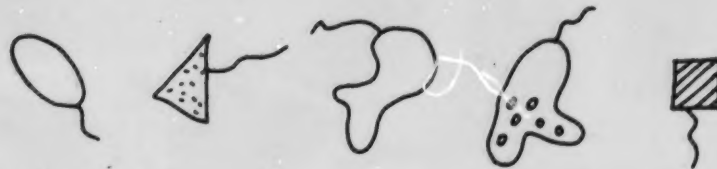
requiring recognition of kilograms as the correct completion of "you could measure how heavy you are in" (item 44).

Concern was expressed by some members of the Interpretation Panel about the validity of measuring skills such as observation and classification with multiple-choice items. The Contract Team acknowledges that only certain aspects of these skills can be assessed. For example, the following item (40) required pupils to identify the defining attribute of a class from sets of instances and non-instances, and then to apply it to a new set. In questions of this type, students do not create their own criteria for classification.

40.

Look at the imaginary tiny animals below.

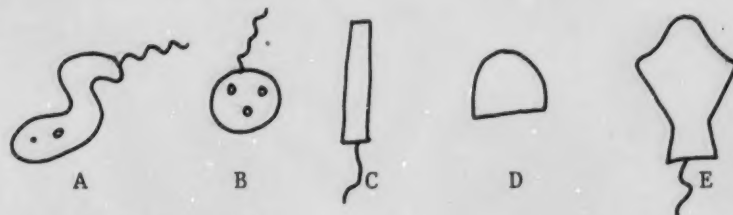
Wibbles look like those in the first row



but none of those in the second row is a Wibble.



Which one in the third row is NOT a Wibble?



	<u>p-values</u>
	<u>Grade 4</u>
A.....	2
B.....	4
C.....	12
*D.....	<u>75</u>
E.....	3

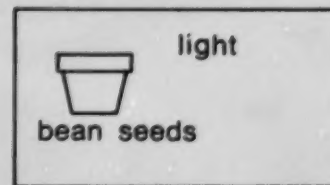
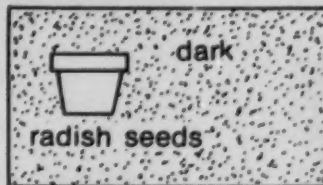
I don't know.... 3

Nonetheless, the Contract Team felt that testing for an important objective in a limited way was better than omitting the objective altogether, as long as the limitations of multiple-choice testing are kept in mind when interpreting the results.

The results on combined skills are particularly interesting. Pupil performance was consistently beyond the expectations of the Contract Team, Management Committee, Review Panel, and Interpretation Panel. Item 32 for example, illustrates the type of reasoning often thought to be beyond the ability of the average grade 4 child:

32.

Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and a pot with 6 bean seeds on the window sill.



He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grow best in the light.

To be able to say this, Tom should have	<u>p-values</u> <u>Grade 4</u>
a) watered both pots more	7
b) watered the radish seeds more	14
*c) put the same kind of seeds in both pots ..	<u>62</u>
d) grown the seeds in water instead of soil..	8
e) I don't know	9

This item required pupils to identify the important variables in the experiment and decide which one should have been controlled. More than 60 percent chose the correct response. Results of this type suggest that many children in the elementary grades are capable of more advanced and abstract science work than is usually offered at that level.

4.1.4.3 Application

Application was not accorded a high priority at grade 4 by the Review Panel, and not surprisingly, the performance on the five items was somewhat inconsistent, as shown in Table 4.4.

TABLE 4.4
RESULTS ON APPLICATION: GRADE 4

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
35	Satisfactory	48	46	47	Reason for keeping milk refrigerated
39	Marginal	21	20	20	Importance of green plants to humans
46	Very Satisfactory	80	70	75	Shadows formed by sun
62	Satisfactory	27	13	20	Bouncing of balls
65	Very Satisfactory	75	68	72	Function of birds' beaks

Item 39, reproduced below, stimulated much discussion among the Interpretation Panel members.

39.

If all green plants died, what would be the most important effect on man?

	<u>p-values</u> <u>Grade 4</u>
a) He would have to eat meat only	12
*b) Sooner or later man would die of starvation	20
c) Man would get a little sick because he couldn't get vitamins	43
d) Man couldn't build houses because there would be no lumber	7
e) The land would be bare and not very pretty for man to look at	11
f) I don't know	6

All agreed on the importance of the concept, but some felt that several of the choices might be valid responses for a grade 4 child. The results probably bear out this contention.

4.1.4.4 Safety

Performance on the five safety goals was quite acceptable, as indicated by Table 4.5.

TABLE 4.5
RESULTS ON SAFETY: GRADE 4

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
20	Satisfactory	84	79	82	Recognition of symbol for poison
21	Satisfactory	89	87	88	Recognition of symbol for explosive substance
22	Satisfactory	80	74	77	Recognition of symbol for corrosive substance
57	Satisfactory	79	80	79	Danger of tasting unknown powders
64	Satisfactory	66	72	69	Precautions in handling pond water

Standard safety symbols were recognized by most children, but the Interpretation Panel felt this was so important that schools should be striving for 100 percent on items such as 20, 21, and 22. Recognition of safety symbols should be stressed in the primary grades along with other safety matters such as traffic signs.

4.1.4.5 Scientific Literacy

The goal of scientific literacy was not considered by the Review Panel to have high priority at grade 4, but four scientific literacy items from the grade 8 test were included, allowing comparison between the grades. The results are given in Table 4.6.

TABLE 4.6
RESULTS ON SCIENTIFIC LITERACY: GRADE 4

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
10	Satisfactory	45	45	45	Need for objective measure
43	Marginal	24	25	24	Limitations of scientific knowledge
53	Satisfactory	48	45	47	Appropriate statement for empirical test
60	Satisfactory	68	61	64	Source of scientific laws

The scores obtained by nine-year-old pupils in the United States National Assessment of Educational Progress on items 10, 43, and 53 were 37 percent, 25 percent, and 41 percent respectively. This indicates

that British Columbia pupils compare favourably with their American counterparts on this goal. Grade 8 students scored 69 percent, 63 percent, 79 percent, and 83 percent respectively on the four items, indicating that during the elementary grades, children are developing the kind of understanding required to answer questions of this type:

10.

Some children were trying to find out which of three light bulbs was brightest. The children said the following things. Which of these gives the best start toward finding the answer?

	<u>p-values</u> <u>Grade 4</u>
a) One bulb looks brightest to me so I already know the answer	14
b) All the bulbs look bright to me so there can't be an answer	14
*c) It would help if we had a way to measure the brightness of a light bulb	<u>45</u>
d) Let's take a vote; each person will vote for the bulb he thinks is the brightest	20
e) I don't know	7

4.1.4.6 Sex Differences

With a few exceptions, the differences between boys' and girls' results on process items were small -- one or two percentage points. For the seven measurement items, however, boys' results were usually five or more percentage points higher than girls'.

For understanding concepts and application, boys' results were often much higher than girls'. On more than half of the items, boys' scores exceeded girls' by four percentage points or more. The differences were small for items dealing with observation of everyday phenomena such as weather (items 8, 16, 50, 68), familiar animals or plants (24, 34, 38), or familiar substances and materials (23, 42, 54). Boys seemed to achieve higher scores than girls on the more conceptual items such as those dealing with Earth's revolution (2), gravitation (2), action of germs (26), function of lungs (41), and concept of speed (7, 51). A particularly large sex difference occurred on item 47, which required students to recognize the correct way of placing two batteries in a flashlight. Boys scored 76 percent on this item, girls scored 49 percent.

The results taken as a whole seem to indicate that a divergence in the interests of boys and girls is evident as early as grade 4.

4.1.4.7 Summary

Generally the grade 4 results were pleasing. Many students at this age level seem to have the knowledge and skills to solve fairly complex scientific problems.

During the process of assembling the test, the Contract Team formed the strong impression that elementary school teachers may be underestimating the thinking abilities of many students. Repeatedly, in the review and pilot testing processes, teachers expressed the opinion that most of the items would be too difficult for grade four students. The results, however, show that students performed beyond the Interpretation Panel's expectations on 70 percent of the items, and most of the teachers on the panel were surprised at how well the children had done.

It may well be that many pupils in the elementary grades have more ability in science than their teachers suspect.

4.2 Achievement: Grade 8

4.2.1 Priority of Goals Assessed

By comparison with the grade 4 test, more emphasis in the grade 8 test was placed on combined process skills and application. Also, sufficient items were included under the heading "Understanding Concepts", to allow results to be reported in each of the four content areas -- biology, chemistry, physics, earth/space science.

A total of 92 items were used, distributed according to Table 4.7.

TABLE 4.7
DISTRIBUTION OF ITEMS BY GOALS: GRADE 8

Goal	Number of Items
1. Understanding concepts	
biology	8
chemistry	5
physics	10
earth/space	8
2. Processes	
classifying	5
communicating	7
measuring	8
combined skills	10
3. Application	15
4. Safety	6
5. Scientific literacy	10

4.2.2 Description of the Test and Administration Procedures

In order that students would not be required to spend more than one hour on the assessment, the test was divided into two parts. Both parts were assembled in separate booklets, and were roughly equivalent in terms of difficulty, coverage of goals, and content areas. Both booklets contained 46 items. Teachers administering the tests were instructed to give alternate booklets to alternate students.

Students were required to read the tests for themselves and record their responses on specially designed optical mark recording cards. Background questions included sex, age, status with respect to Science 8, and amount of time spent per week on science homework. Sixty minutes were allotted to the test, including 10 minutes for distribution of materials and answering of background questions.

4.2.3 Description of the Population

All students who were registered in grade 8 were to be included in the assessment. Principals were instructed to include as many of the "atypical (special education) children" as possible, using their discretion in extreme cases.

A total of 41,515 students wrote the test: 20,882 for Booklet A, and 20,633 for Booklet B. On the basis of the February 1978 Form B data, this represents 90.7 percent of students enrolled in grade 8.

TABLE 4.8
AGE DISTRIBUTION: GRADE 8

Age	Distribution of Students	Percent
16 years or older	391	0.9
15 years	2,466	6.0
14 years	14,030	34.0
13 years	23,943	58.0
12 years	379	0.9
11 years or younger	59	0.1

Table 4.9 shows that most students reported spending more than 30 minutes per week on science homework.

TABLE 4.9
TIME SPENT ON SCIENCE HOMEWORK: GRADE 8

Minutes per Week	Number of Students	Percent
None at all	3,877	9.3
Less than 30	10,492	25.3
30 to 60	14,141	34.1
60 to 90	7,379	17.8
More than 90	5,138	12.4
No response	488	1.1
TOTAL	41,515	100.0

4.2.4 Results by Goal

4.2.4.1 Understanding Concepts

Table 4.10 shows the results in the four content areas, together with the ratings given by the Interpretation Panel.

TABLE 4.10
RESULTS ON UNDERSTANDING CONCEPTS: GRADE 8

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
BIOLOGY					
A-16	Strength	91	93	92	Life history of butterfly
A-24	Very Satisfactory	82	91	86	Nutrition
A-27	Weak	40	42	41	Protein content of food
A-36	Marginal	40	42	41	Theory of natural selection
A-38	Satisfactory	70	73	71	Seeds come from flowers
B-15	Weak	33	25	29	Function of sweating
B-31	Marginal	47	38	42	Importance of green plants
B-44	Satisfactory	76	71	73	Function of lungs
CHEMISTRY					
A-17	Weak	29	25	27	Chemical change
A-31	Satisfactory	59	59	59	Concept of mixture
A-43	Very Satisfactory	84	83	83	Conditions for evaporation
B-3	Satisfactory	73	61	67	Burning candle in an enclosed space
B-40	Marginal	59	47	53	Concept of a solution
PHYSICS					
A-1	Very Satisfactory	91	73	82	Arrangement of batteries in a flashlight
A-10	Marginal	38	29	34	Sources of energy
A-18	Satisfactory	73	64	68	Concept of speed
A-32	Satisfactory	64	70	67	Inversion of mirror image
A-46	Satisfactory	47	44	46	Variables affecting pendulum swing
B-2	Satisfactory	75	56	65	Principle of magnetic compass
B-10	Weak	54	40	47	Temperature of mixture of hot and cold water
B-19	Satisfactory	46	32	39	Unequal arm balance
B-36	Satisfactory	65	62	63	Pitch of chimes of different lengths
B-45	Marginal	57	44	50	Principle of gravitation

Results on Understanding Concepts: Grade 8 (Continued)

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
EARTH/SPACE SCIENCE					
A-3	Marginal	52	34	43	Cause of night and day
A-15	Marginal	37	32	34	Hardness testing of materials
A-25	Weak	30	20	25	Why fossil fish is found on a mountain
A-42	Very Satisfactory	72	73	73	Sun is a star
B-4	Marginal	47	41	44	Causes of winds
B-18	Very Satisfactory	73	65	69	Succession of life forms
B-26	Satisfactory	78	72	75	Revolution of Earth around Sun
B-39	Very Satisfactory	87	82	84	Earth's surface is mostly water

Overall, the performance on this goal was satisfactory, although weaknesses were found on some items. The Interpretation Panel rated performance on five of the 31 items as weak. Items A-24 and A-27 provide an interesting contrast. Performance on A-24 was very satisfactory (86 percent), while performance on A-27 was weak (41 percent). The former required application of a general nutrition rule, while the latter required recognition of a high protein food.

A-24.

A meal consists of milk, bread and butter, meat, and cake. To satisfy the rules of good nutrition, what should be added to this meal?

	<u>p-values</u> <u>Grade 8</u>
*a) A green or yellow vegetable	86
b) Baked beans	2
c) Cheese	5
d) Coffee or tea	2
e) Pickles and olives	2
f) I don't know	2

A-27.

An average serving of which of the following foods would provide the most protein for building and repairing body tissues?

	<u>p-values</u> <u>Grade 8</u>
a) Boiled potatoes	6
b) Green beans	22
*c) Lean meat	41
d) Oatmeal	13
e) White bread	5
f) I don't know	13

Less than one-third of the students recognized that the main function of "sweating" is to help cool the body (B-15), or identified burning wood as an example of chemical change (A-17). About one-third of the students incorrectly added the temperatures of two containers of water to find the temperature of a mixture of the two (B-10). Only 25 percent answered the following question correctly, but this is similar to the result obtained on the same item by a sample of 13-year-old American children in the National Assessment of Educational Progress (1972/73).

A-25.

A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that

	<u>p-value</u> <u>Grade 8</u>
a) fish once lived on the mountain	4
b) the relative humidity was once very high	10
* c) the mountain was raised up after the fish died	<u>25</u>
d) fish used to be amphibians like toads and frogs	8
e) the fossil fish was probably carried to the mountain by a great flood	45
f) I don't know	5

Some items judged as marginal by the Interpretation Panel indicate important areas which may warrant more emphasis in the schools. Fewer than half of the students recognized a charged battery as a source of energy (B-10), green plants as the only producers of food (B-31), or the spinning of the Earth as the cause of night and day (A-3).

On the other hand, performance on other items indicates that many grade 8 students have a good grasp of such concepts as the life cycle of the butterfly (A-43), the working of a flashlight (A-1), the constituents of the Earth's surface (B-39), evolutionary succession (B-18), conditions for evaporation (A-43), and speed (A-18).

4.2.4.2 Processes

Table 4.11 on the following page, summarizes the process items together with the Interpretation Panel's ratings.

TABLE 4.11
RESULTS FOR PROCESSES: GRADE 8

Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
CLASSIFYING					
A-21	Satisfactory	43	58	50	Selecting instances of two-way classification
A-22	Very Satisfactory	82	85	83	Selecting non-instances of one-way classification
A-23	Strength	87	91	89	Identifying common attributes of a class
B-17	Strength	91	89	90	Identifying common attributes of a class
B-29	Very Satisfactory	63	72	67	Identifying and applying common attributes of a class
COMMUNICATING					
A-11	Very Satisfactory	74	72	73	Matching graph with record of data
A-37	Very Satisfactory	67	67	67	Reading graphs
A-44	Satisfactory	56	59	57	Describing change
B-5	Satisfactory	71	60	66	Interpolation
B-6	Satisfactory	48	37	43	Extrapolation
B-23	Satisfactory	64	61	62	Finding average of repeated readings
B-46	Strength	88	90	89	Interpreting graphs
MEASURING					
A-12	Satisfactory	68	68	68	Selection of suitable container for measuring rainfall
A-19	Weak	23	22	22	Technique for measuring thickness of razor blades
A-28	Strength	92	93	92	Measurement of volume by displacement of liquid
A-41	Satisfactory	60	58	59	Reading volume in graduated cylinder
B-11	Strength	90	92	91	Concept of a standard length
B-21	Very Satisfactory	92	89	90	Actual measurement with ruler provided
B-27	Satisfactory	41	40	40	Selection of instruments to measure period of a pendulum
B-38	Weak	19	8	14	Proper technique for measurement with ruler

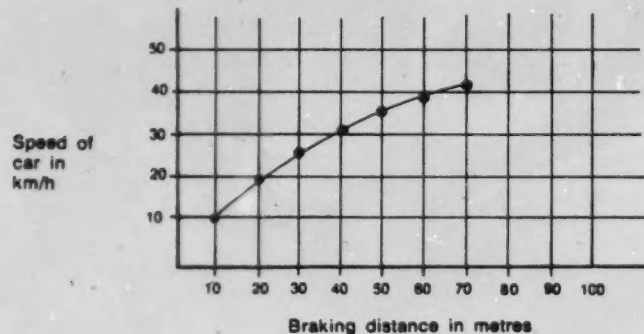
Results for Processes: Grade 8 (Continued)

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
COMBINED SKILLS					
A-4	Satisfactory	34	35	35	Designing an experiment
A-5	Satisfactory	54	57	56	Controlling variables
A-6	Satisfactory	36	38	37	Identifying dependent variable
A-30	Very Satisfactory	75	75	75	Inference from experimental data
A-39	Very Satisfactory	77	81	79	Controlling variables
B-1	Strength	83	86	84	Drawing conclusion from data
B-12	Marginal	36	35	35	Drawing conclusion from data
B-20	Weak	38	33	36	Experimental design for multiple trials
B-32	Very Satisfactory	74	78	76	Controlling variables
B-42	Very Satisfactory	62	62	62	Controlling variables

The students did very well on most of the process items. In particular, the Interpretation Panel was very satisfied with performance on the skills of classifying and communicating.

Two of the communicating items (B-5 and B-6) were quite similar but gave very different results:

This graph shows how many metres it takes a car to stop after braking (braking distance), when the car is travelling at different speeds.



B-5.

Look at the graph. Predict the braking distance at 15 km/h.

	<u>p-values</u> <u>Grade 8</u>
a) 10 metres	7
*b) 15 metres	66
c) 5 metres	9
d) 20 metres	10
e) I don't know	9

B-6.

Look at the graph again. Predict the braking distance at 44 km/h.

	<u>p-values</u> <u>Grade 8</u>
a) 70 metres	20
*b) 75 metres	43
c) 100 metres	5
d) 60 metres	17
e) I don't know	14

Evidently, students found interpolation between two data points much easier than extrapolation beyond the data points. As many as 14 percent chose the "I don't know" option for item B-6. This could indicate that extrapolation is a skill that is not commonly practised in the elementary grades.

Performance on the measuring objective reflected a fair degree of understanding about measurement by the students. The item with the poorest performance (A-19) could be explained in part as failure in computation rather than failure to grasp the notion of how to measure very thin objects. Another item which reflected very weak performance was B-38 which required students to identify the most accurate method for measuring the length of a line with a ruler. Only 14 percent chose the correct response on this item and apparently this technique is not being taught in the schools.

Ten items were included for the objective of combined skills and they varied greatly in terms of content and difficulty. Overall, the Interpretation Panel was quite satisfied with performance on this objective and only two results were interpreted as less than satisfactory (B-12 and B-20).

There were many difficult items on which performance was very encouraging. The need for controlling variables seems to be well understood by the majority of students as illustrated by items A-39, B-32 and B-42. Performance on items requiring the interpretation of experimental data was very acceptable (e.g., A-30 and B-1).

As expressed by the Interpretation Panel, "process skills are obviously well taught in general". This strong performance may be the result of the emphasis on process in the former Elementary Science Programme (1966).

4.2.4.3 Application

Results for the 15 application items are given in Table 4.12.

Very few student (6 percent) knew that paper, disinfectants, and alcohol can all be made from wood (B-22). Just over one-third recognized our ultimate dependance for food on green plants (B-33). On the other hand, about 80 percent could correctly use thermal expansion to open a tight lid on a jam jar, and knew why fanning helps a campfire burn, and why refrigeration helps keep milk fresh.

The Interpretation Panel rated performance on only four items as less than satisfactory, and judged overall performance on the application goal as "satisfactory in general".

TABLE 4.12
RESULTS FOR APPLICATION: GRADE 8

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-2	Very Satisfactory	79	83	81	Different expansion rates to jam jar
A-8	Marginal	28	23	26	Operating principle of refrigerator
A-14	Very Satisfactory	86	78	82	Factors affecting combustion campfire
A-20	Marginal	53	35	44	Conservation of energy of a bouncing ball
A-29	Satisfactory	49	44	46	Result of changes in an ecosystem
A-35	Satisfactory	61	60	60	Inference from single barometer reading
B-7	Very Satisfactory	64	72	68	Inheritance of acquired characteristics
B-9	Marginal	34	11	22	Electrical circuits
B-13	Very Satisfactory	91	84	88	Shadows formed by sun
B-16	Very Satisfactory	80	73	76	Function of birds' beaks
B-22	Weak	6	5	6	Products made from wood
B-25	Satisfactory	63	47	55	Volume expansion of steam
B-30	Satisfactory	44	39	41	Principle of moments on equal arm balance
B-33	Marginal	41	34	38	Humans' dependence on green plants
B-35	Very Satisfactory	77	79	78	Effect of refrigeration on bacteria

4.2.4.4 Safety

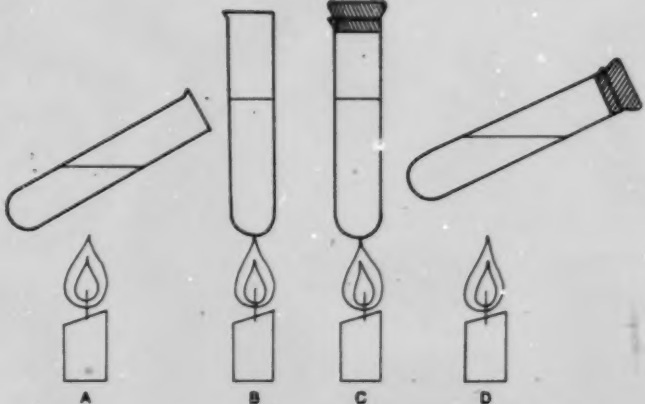
Results for the five safety items are shown in Table 4.13

TABLE 4.13
RESULTS FOR SAFETY: GRADE 8

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-9	Very Satisfactory	91	93	92	Danger of testing unknown substances
A-33	Marginal	40	23	32	Purpose of fuse or circuit breaker
A-45	Very Satisfactory	75	78	77	Treatment for acid on skin
B-14	Satisfactory	70	75	72	Precautions when working with pond water
B-34	Weak	30	25	27	Heating liquid in test tube
B-41	Very Satisfactory	82	84	83	Aid for person with clothing on fire

The Interpretation Panel rated overall performance on safety items as satisfactory, but called for more emphasis on safety in teacher education and in-service workshops. The result giving most cause for concern is item B-34:

B-34.
Which is the correct method of heating a liquid in a test tube?



	p-values Grade 8
*a)	27
b)	32
c)	15
d)	22
e) I don't know	3

The disturbing aspect of this result is that 37 percent of the students chose one of the two options where a stopper is in the mouth of the test tube. Junior secondary science teachers should be aware that many of their students may not know basic safety procedures such as this one.

On the other hand, most students selected the correct procedures for responding to the emergency situations of burning clothing (B-41) and acid spills on the skin (A-45).

4.2.4.5 Scientific Literacy

Ten items were included under the heading scientific literacy. Most dealt with the nature of statements in science and of scientific procedures. Results are given in Table 4.14

TABLE 4.14
RESULTS FOR SCIENTIFIC LITERACY: GRADE 8

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-7	Very Satisfactory	79	78	78	Recognizing testable statements
A-13	Marginal	34	28	31	Identifying a hypothesis
A-26	Weak	51	51	51	Belief in unlucky numbers
A-34	Satisfactory	67	72	69	Need for objective measure
A-40	Marginal	50	49	49	Definition of a hypothesis
B-8	Weak	61	64	62	Limitations of scientific knowledge
B-24	Satisfactory	69	75	72	Differentiating between opinions and facts
B-28	Very Satisfactory	85	88	86	International nature of science
B-37	Very Satisfactory	83	83	83	Source of scientific laws
B-43	Weak	23	32	27	Personality stereotype of a scientist

Apparently the Interpretation Panel was a little concerned about performance on this goal as five of the ten items were rated less than satisfactory. The ability to distinguish among fact, hypothesis, and opinion was the subject of three items (A-12, A-40, and B-24). Many students seem to be unfamiliar with the term hypothesis as is evident by the results on items A-13 and A-40. A high percentage of students responded in the I don't know category on A-13 (22 percent) and A-40 (18 percent). On the other hand, item B-24, which required students to distinguish between opinion and fact, was answered successfully by 72 percent.

The students experienced little difficulty recognizing the kinds of claims which could be empirically tested (item A-7), and were able to identify with some success the most appropriate procedures for testing a statement (A-34). The Interpretation Panel was concerned that almost half the students (41 percent) responded that 13 was an unlucky number -- even on a science test:

A-26.		
Which number is unlucky?		p-values
		Grade 8
a)	3	1
b)	7	2
c)	11	2
d)	13	41
*e)	There are no unlucky numbers	51
f)	I don't know	2

It is difficult to say how the students interpreted this question - perhaps they felt constrained by the wording of the question to try to identify a number. More research is needed to determine how pervasive and strong is the belief in unlucky numbers or other superstitions.

Items B-8 and B-37 were of interest to the Contract Team since they appeared on both the grades 4 and 8 tests, providing an opportunity to look for evidence of development in the beliefs of students over a period of four years. In the case of item B-8, which asked students "Which topic do scientists know everything about?" the result in grade 8 was 63 percent compared to 24 percent in grade 4. This is very encouraging and suggests that science instruction in the elementary grades is addressing issues like this one. Similarly, on item B-37, which asks where scientific laws come from, the result in grade 8 was 83 percent compared to 64 percent in grade 4.

One item which provided a surprise for both the Contract Team and the Interpretation Panel was item B-43.

B-43.

Bill always makes good grades in school but is a practical joker. Frank also makes good grades but has no sense of humour. Janet is a serious, intelligent, and popular girl. Who would most likely become a research scientist?

	<u>p-value</u> <u>Grade 8</u>
a) Frank	13
b) Janet	51
c) Either of the boys	4
*d) Any of the three	<u>27</u>
e) I don't know	3

This result seems to suggest that the stereotype of scientists as serious, intelligent persons is compelling, even when pitted against the stereotype of scientists as male.

The Interpretation Panel summarized performance on scientific literacy as "mixed", and suggested that some of the weak and marginal performances might be reflections of misconceptions commonly held by adults in society generally.

4.2.4.6 Sex Differences

The differences between boys' and girls' results on the grade 8 test were similar to those found on the grade 4 test, but were slightly larger. On the process, safety, and scientific literacy goals, boys

and girls generally performed equally well. On the application items, the mean percent correct for boys was 57 compared to 52 for girls. On understanding concepts, the mean percent correct for boys was seven percentage points higher than for girls, although no mean difference was found for the biology items in that goal.

4.2.4.7 Summary

Taken as a whole, the results of the grade 8 test can be considered to be very encouraging. The evidence indicates that students enter secondary school with well-developed skills in basic processes, and a satisfactory level of understanding of science concepts.

4.3 Achievement: Grade 12

4.3.1 Priority of Goals Assessed

The distribution of items by goal (Table 4.15) in the final version of the grade 12 achievement test reflects the relative emphasis placed on each goal by the Management Committee and Review Panel.

TABLE 4.15
DISTRIBUTION OF ITEMS BY GOAL: GRADE 12

Goal	Number of Items
Understanding Concepts	
Biology	11
Chemistry	9
Physics	11
Earth/Space Science	10
Processes	
Combined Skills	21
Application	
Biology	10
Chemistry	7
Physics	9
Earth/Space Science	6
Safety	6
Scientific Literacy	20
Total	120

4.3.2 Description of the Test and Administration Procedures

As was done in the case of the grade 8 achievement test, the grade 12 test was divided into two parts in separate booklets, with alternate parts being administered to alternate students. Sixty minutes were allotted for completion of the test, including all administrative procedures. Students responded on specially designed optical mark recording cards.

The first section of each answer book contained 12 questions to elicit the following background information:

Date of birth
Sex
Minutes per week spent on science homework
Secondary science courses completed
Secondary science courses being taken currently
Hours per week spent in part-time employment
Father's education
Mother's education
Plans after leaving school
Reasons for these plans
Father's occupation
Mother's occupation

4.3.3 Description of Respondents

All students registered in grade 12 were to be included in the assessment. Principals were asked to include as many "atypical (special education) students" as possible, but were requested to exercise their discretion in this matter.

A total of 26,416 students wrote the grade 12 test: 13,341 wrote Booklet A, and 13,075 wrote Booklet B. Using the February 1978, Form B data, this total represents 78.6 percent of the students enrolled in grade 12. Of the 26,416 students tested, 12,790 were males, 13,538 were females, and 88 did not state their sex.

The age distribution of the students who responded is shown in Table 4.16.

TABLE 4.16
AGE DISTRIBUTION OF GRADE 12 STUDENTS

Age (years-months)	Frequency	Percent
20 years or older	287	1.1
19 years	1,111	4.2
18-10 - 19-0	790	3.0
18-7 - 18-9	1,038	3.9
18-4 - 18-6	1,317	5.0
18-1 - 18-3	4,966	18.8
17-10 - 18-0	5,394	20.4
17-7 - 17-9	5,395	20.4
17-4 - 17-6	4,692	17.8
17-1 - 17-3	367	1.4
16 years	431	1.6
15 years or younger	44	0.2
Missing	584	2.2

A majority of the students who reported taking science courses said that they spend an hour or more per week on science homework; as shown in Table 4.17.

TABLE 4.17
MINUTES PER WEEK SPENT ON SCIENCE HOMEWORK: GRADE 12

How many minutes per week on the average do you spend on science homework?	Frequency	Percent
I do not take a science course	12,738	48.2
None at all	2,028	7.7
Less than 30 minutes per week	1,584	6.0
30 to 60 minutes per week	2,634	10.0
60 to 90 minutes per week	2,374	9.0
More than 90 minutes per week	4,692	17.8
Missing	146	0.6
Multiple.	220	0.8

Students were assigned to three categories according to the science courses they had taken or were taking at the senior secondary level. Thirty-nine percent had successfully completed or were currently taking a science course at the grade 12 level (40 percent of the boys, 37 percent of the girls). Twenty-five percent had successfully completed or were currently taking a science course at the grade 11 level, but none at the grade 12 level (25 percent of the boys, 25 percent of the girls). Thirty-six percent had not successfully completed and were not currently taking courses in science at either grade 11 or grade 12 level (34 percent of the boys, 37 percent of the girls).

Table 4.18 shows students' status with respect to part-time employment. Fifty-five percent reported having a part-time job, and of these, 62 percent reported spending 10 or more hours working. More males than females reported working part-time.

TABLE 4.18
HOURS PER WEEK SPENT ON PART-TIME JOB: GRADE 12

If you have a job, how many hours per week do you spend on it?	Percent		
	Male	Female	Total
Less than 5 hours	5.8	6.4	6.1
5 - 9 hours	14.8	14.8	14.8
10 - 20 hours	22.7	22.8	22.8
More than 20 hours	15.4	7.8	11.5
I do not have a part-time job	38.2	45.6	41.9
Missing	2.7	2.5	2.6
Multiple	0.4	0.2	0.3

The level of education of parents or guardians was reported by students as shown in Table 4.19.

TABLE 4.19
EDUCATION OF PARENTS: GRADE 12

Highest Level of Education Completed	Percent	
	Father	Mother
Elementary school	10.5	7.5
Junior secondary school	17.6	19.3
Senior secondary school	18.9	32.8
Trade or vocational school	7.6	6.8
Technical training or some university	9.7	11.2
Completed bachelor's degree	5.3	4.1
Completed post-graduate degree	5.8	2.6
I don't know	15.6	14.1
Missing	0.5	0.8
Multiple	8.6	0.7

Parents' or guardians' occupations were reported as shown in Table 4.20. Almost half (49.1 percent) the grade 12 students classified their fathers' or guardians' occupations as managerial, professional, skilled, or technical. Forty-four percent classified their mothers' or guardians' occupations as homemaker.

TABLE 4.20
OCCUPATION OF PARENTS: GRADE 12

Occupation Category	Percent	
	Father	Mother
Clerical (secretary, etc.)	1.0	13.6
Deceased	3.2	1.0
Farmer (own farm)	2.5	0.7
Managerial (own business, company manager, executive)	19.2	4.9
Mining, logging, fishing, farm work	5.9	0.4
Professional (doctor, lawyer, teacher, graduate engineer)	9.9	7.2
Retired	3.3	0.9
Sales (retail business, insurance, real estate)	5.1	4.5
Semi-skilled work (factory, millworker)	6.5	2.1
Service (armed forces, police, motel employee)	4.0	1.8
Skilled worker (construction, production, tradesmen)	16.9	0.8

Occupation of Parents: Grade 12 (Continued)

Occupation Category	Percent	
	Father	Mother
Technical (technologist, electronic technician)	3.1	0.6
Transport, communication (telephone, bus, newspaper)	3.1	0.7
Unskilled worker (labourer)	3.2	3.5
Homemaker	0.2	43.5
Other	10.2	11.3
Missing	1.1	1.0
Multiple	1.5	1.4

Table 4.21 shows students' responses to the question "What do you plan to do after leaving secondary school?" Sixty-three percent of the students reported planning further education after leaving secondary school. Twice as many males (18 percent) as females (9 percent) stated an intention to enter vocational, art or trade training, or a technical institute.

TABLE 4.2.1
STUDENTS' PLANS AFTER SECONDARY SCHOOL: GRADE 12

What do you plan to do after leaving secondary school?	Percent		
	Male	Female	Total
Look for a job	14.8	17.8	16.4
Business school	1.2	2.6	1.9
Vocational, art or trade training	11.1	4.7	7.8
Technical institute	7.1	4.0	5.5
Community college university transfer program	9.4	10.1	9.7
Community college career program	4.7	11.2	8.0
University	17.2	16.6	16.9
Take a year off and then return to an educational program	12.8	13.9	13.3
Take a year off and then look for a job	1.4	1.0	1.2
Other plans	8.3	7.2	7.8
Undecided	9.6	9.1	9.3
Missing	0.4	0.2	0.4
Multiple	1.9	1.6	1.7

4.3.4 Results by Goal

The results for items with the Interpretation Panel's ratings are reported for each goal in the following sequence of tables.

4.3.4.1 Understanding Concepts: Biology

Table 4.22 shows the results for this goal.

TABLE 4.22
RESULTS FOR BIOLOGY CONCEPTS: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-2	Strength	92	96	94	Nutrition
A-14	Marginal	55	51	53	Function of white blood cells
A-31	Satisfactory	62	64	63	Iodine test for starch
A-34	Weak	44	66	56	Embryo develops in uterus
A-44	Marginal	50	45	48	Water and CO ₂ used in photosynthesis
A-52	Marginal	53	54	53	Natural selection
B-3	Marginal	66	57	61	Function of perspiration
B-15	Marginal	68	54	61	Function of kidney
B-33	Satisfactory	60	69	65	Genes determine heredity
B-35	Marginal	72	59	65	Green plants produce food
B-60	Satisfactory	50	49	49	Sequence of mitosis

Obviously, the Interpretation Panel felt that 50 to 60 percent correct is not a satisfactory level for these basic biology concepts. The single clear weakness was identified in item A-34 which required students to recognize the uterus as the place where the human embryo normally develops. On the other hand, performance on item A-2 was regarded as a strength.

A-2.

A meal consists of milk, bread and butter, meat, and cake. To satisfy the rules of good nutrition, what should be added to this meal?

	p-values Grade 12
*a) A green or yellow vegetable	95
b) Baked beans	1
c) Cheese	2
d) Coffee or tea	1
e) Pickles and olives	0
f) I don't know	1

In particular, the Interpretation Panel noted that understanding of "life process concepts" was marginal.

4.3.4.2 Understanding Concepts: Chemistry

Results for this goal are summarized in Table 4.23.

TABLE 4.23
RESULTS FOR CHEMISTRY CONCEPTS: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-3	Marginal	54	47	50	Meaning of "ion"
A-15	Very Satisfactory	79	74	76	Family of elements have similar chemical properties
A-32	Weak	39	30	35	Electric conduction is test for ions in solution
A-50	Marginal	54	46	50	Electrons are involved in chemical bonds
A-58	Marginal	34	30	32	Atomic number and weight
B-2	Marginal	51	48	49	Meaning of "compound"
B-16	Very Satisfactory	78	76	77	Name elementary atomic particles
B-36	Weak	24	17	21	Meaning of "chemical equilibrium"
B-43	Weak	26	16	20	Chemical products of burning candle

The Interpretation Panel felt that the results indicate "no depth of understanding" and "superficial learning". Many students knew that atoms consist of electrons, protons, and neutrons, but fewer knew that electrons are involved in forming chemical bonds or forming ions, and even fewer knew that the presence of ions in solution can be detected by finding out if the solution conducts electricity. The performance on this last mentioned item (A-32) is especially disappointing in view of the emphasis on electro-chemistry in the grade 10 science curriculum.

4.3.4.3 Understanding Concepts: Physics

Results for this goal are summarized in Table 4.24.

The Interpretation Panel judged overall performance on this goal as marginal to weak. The Panel called for more contact (in schools) with real life and real situations in physics.

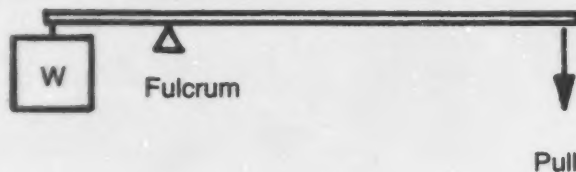
TABLE 4.24
RESULTS FOR PHYSICS CONCEPTS: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-1	Marginal	58	47	52	Reflection in plane mirror
A-7	Marginal	67	43	54	Nuclear reactors provide energy as electricity
A-30	Weak	36	28	32	Blue surface colour is the result of absorption of other colours
A-33	Satisfactory	74	64	69	Molecules are further apart in steam than in ice
A-35	Marginal	82	24	52	Function of carburetor
A-57	Marginal	59	34	46	Concept of inertia
B-1	Strength	88	80	84	Gravity less on Moon than on Earth
B-14	Very Satisfactory	72	66	69	Solid conductors have loosely bound electrons
B-34	Weak	25	29	27	Uniform velocity the result of applied force balanced by friction
B-37	Marginal	54	48	51	Meaning of "efficiency" of machines
B-47	Weak	48	40	43	Principle of lever

Metallic conduction (B-14) and the kinetic molecular theory (A-33) seem understood, although the performance on item (B-47) leaves much to be desired.

B-47.

The advantage of using a lever such as that shown in the diagram to raise a weight W instead of lifting it directly is that



- a) less energy is required
- b) it is quicker
- *c) less force is needed
- d) less movement is needed
- e) less work has to be done
- f) I don't know

p-values
Grade 12

28
2
43
4
15
5

Of particular interest with respect to the physics questions is the especially poor performance of girls, who scored, on the average, 14 percentage points lower than the boys.

4.3.4.4 Understanding Concepts: Earth/Space Science

TABLE 4.25
RESULTS FOR EARTH/SPACE SCIENCE CONCEPTS: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-5	Weak	32	22	27	Composition of atmosphere
A-18	Marginal	56	39	47	Why is fossil fish found on mountain?
A-29	Marginal	33	23	28	Recognition of cirques
A-43	Marginal	56	45	51	Classification of streams
A-45	Weak	41	33	37	Loam is best type of soil
A-49	Marginal	72	60	66	Sand increases wind's weathering effect on rocks
B-6	Very Satisfactory	69	67	68	Recognition of glacial valley
B-46	Marginal	39	38	39	Determining composition of minerals
B-50	Satisfactory	60	43	51	Moon phases
B-59	Marginal	34	14	24	Earth-Sun distance is about eight light-minutes

The Interpretation Panel classified the performance on most items as marginal, for example, item A-18.

A-18.

A fossil of an ocean fish was found on a rock outcrop on a mountain. This probably means that

	<u>p-values</u> <u>Grade 12</u>
a) fish once lived on the mountain	2
b) the relative humidity was once very high	5
*c) the mountain was raised up after the fish died	47
d) fish used to be amphibians like toads and frogs	6
e) the fossil fish was probably carried to the mountain by a great flood	33
f) I don't know	5

The results indicate that earth and space science topics may not be getting their due share of attention in the secondary school years. Data from the junior-secondary teacher questionnaire support this claim (See Vol II). As in the case of physics concepts, males' performance is clearly superior to females' on most of the earth/space science items, the discrepancy being, on the average, 11 percentage points. The difference is especially noticeable on the two space-science items (B-50 and B-59). Item B-59 is reproduced below:

B-59.	
If a sudden change took place on the surface of the Sun, the change would first be observed on Earth after about	
	<u>p-values</u>
	<u>Grade 12</u>
a) 1 second	16
b) 10 seconds	10
c) 30 seconds	8
*d) 8 minutes	24
e) 1 hour	12
f) I don't know	27

For the four content areas combined, the mean percent correct on the goal of understanding concepts was 51 (males 55, females 47).

Overall performance on the understanding concepts goal was rated by the Panel as marginal to weak. The Panel called for less emphasis in junior secondary grades on preparation for senior courses and more on practical knowledge of concepts and application. In particular, the Panel noted the need for units in the junior secondary science curriculum on human physiology and anatomy, including life processes.

4.3.4.5 Processes

Process questions in the grade 12 test were confined to combined skills questions, involving various aspects of experimental design and interpretation of data. The results are summarized in Table 4.26.

TABLE 4.26
RESULTS ON PROCESSES: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-9	Marginal	35	37	36	Evaluating conclusions from given data
A-10	Marginal	44	42	43	
A-11	Weak	23	24	24	
A-12	Weak	30	28	29	
A-13	Marginal	45	45	45	
A-36	Weak	42	44	43	Controlling variables
A-37	Very Satisfactory	82	84	83	
A-38	Weak	26	12	20	
A-39	Satisfactory	63	59	61	Repeated readings
A-40	Marginal	58	60	59	Interpreting data
B-8	Marginal	52	50	51	Controlling variables
B-9	Weak	22	20	21	Interpreting data
B-10	Satisfactory	63	61	62	
B-11	Weak	38	38	38	Controlling variables
B-12	Marginal	57	57	57	Interpreting variables
B-13	Marginal	42	43	43	Controlling variables
B-38	Satisfactory	69	72	71	Interpreting data
B-39	Marginal	56	58	57	
B-40	Marginal	48	50	49	
B-41	Marginal	49	50	50	Experimental design
B-42	Very Satisfactory	67	76	72	

Overall performance on these items was rated by the Interpretation Panel as marginal. These were generally quite difficult items however, and often required students to study an extensive amount of information before answering the questions. One of the less difficult items was A-40.

A-40. Bubble-Pop and Zing are two brands of orange drink. A test was done by a market researcher on 120 people who said they were regular Zing drinkers. Each person was blindfolded and then given a glass of Bubble-Pop and a glass of Zing. They were asked which drink they liked better. A newspaper advertisement later reported that "Just over half of the Zing drinkers who stated a preference chose Bubble-Pop." What does this probably mean?

	p-value
	Grade 12
a) Bubble-Pop tastes better than Zing	13
b) More people like Bubble-Pop than Zing	14
c) When blindfolded, people like Bubble-Pop better than Zing	11
*d) There is little taste difference between Bubble-Pop and Zing	59
e) I don't know	2

The Panel judged this performance as marginal.

An interesting aspect of the results on combined skills is that girls' scores were virtually the same as boys', except for item A-38 which required some arithmetic.

A-38.

The drug noscapine is used to control coughing.

Two different brands of cough tablets are advertised:

Brand 1 - Each tablet contains 10 mg of noscapine as the only active ingredient, and users are advised to take three tablets every four hours. 50 tablets cost \$2.50.

Brand 2 - Each tablet contains 14 mg of noscapine as the only active ingredient, and users are advised to take two tablets every four hours. 50 tablets cost \$5.20. Brand 2 is advertised as "extra strength".

If a person wanted to take tablets for a bad cough, which brand would be the better choice?

	p-values Grade 12
*a) Brand 1 because they are cheaper	20
b) Brand 2 because they are extra strength	24
c) It would depend on how bad the cough was	32
d) It would be necessary to try them to decide	19
e) I don't know	4

The Panel rated performance on this item as weak

4.3.4.6 Application: Biology

Results for this goal are summarized in Table 4.27.

TABLE 4.27
RESULTS FOR BIOLOGY APPLICATION: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-16	Satisfactory	66	70	68	Genetic dominance
A-17	Satisfactory	71	70	70	Inheritance of environmental trait
A-22	Marginal	56	50	53	Advantage of capillary system in blood circulation
A-48	Weak	48	44	46	Recognition of producers in food web
B-5	Strength	83	86	84	Recognition of hereditary trait
B-17	Satisfactory	74	74	74	Risks in reheating meat
B-18	Marginal	46	50	48	Inheritance of blood type
B-51	Weak	17	13	15	Excess fertilizer on house plants
B-52	Weak	60	51	55	Importance of plants in food chain
B-54	Satisfactory	67	63	65	Vegetative reproduction in starfish

The Panel members were reasonably satisfied with performance on this goal but identified weaknesses in knowledge of photosynthesis, human physiology, and ecology. They suggested that lack of ability to apply may be related to a weak conceptual base. Notably, four of the five items for which performance was rated as satisfactory or better dealt with aspects of reproduction. The three weaknesses were items related to ecology concepts, while the two marginal items dealt with human physiology.

4.3.4.7 Application: Chemistry

Results for this goal are shown in Table 4.28.

TABLE 4.28
RESULTS FOR CHEMISTRY APPLICATION: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-42	Weak	18	15	17	Action of soap
A-53	Marginal	45	41	43	Kinetic molecular explanation of diffusion
A-55	Weak	36	22	29	Radioactive half-life
B-7	Weak	16	10	13	Products of wood
B-22	Weak	49	34	41	Increasing carbon-dioxide in air from burning fossil fuels
B-45	Weak	40	33	37	Fixed proportions in chemical reaction
B-56	Weak	38	26	32	Gases have mass

The panel rated performance on this goal as deplorably weak and recommended greater attention to the practical application of theoretical concepts in school. Performance on the following two items (B-7 and B-22) illustrate the cause for their concern.

B-7.

Which of the following products can be made from wood?

1. Paper	2. Disinfectants	3. Alcohol	<u>p-values</u>
			<u>Grade 12</u>
a) 1 only			56
b) 1 and 3			28
c) 2 only			1
*d) 1, 2, and 3			<u>13</u>
e) I don't know			1

B-22.

Atmospheric carbon dioxide is believed to be increasing due to

	<u>p-values</u> <u>Grade 12</u>
a) decreased carbon dioxide fixation by green plants.	16
b) increased release from volcanoes.	2
*c) increased burning of fossil fuels.	41
d) cutting down of too many trees.	24
e) I don't know.	16

4.3.4.8 Application: Physics

Results for this goal are shown in Table 4.29.

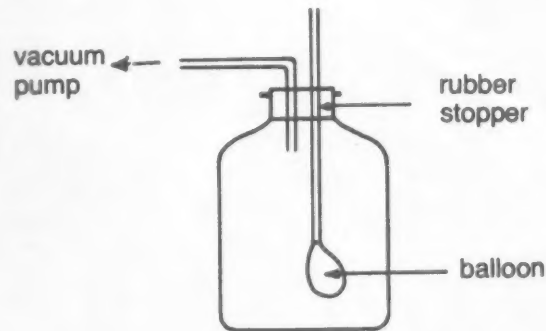
TABLE 4.29
RESULTS FOR PHYSICS APPLICATION: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-4	Weak	12	8	10	Function of insulation
A-28	Weak	55	36	45	Efficiency
A-47	Marginal	68	45	56	Electrical circuits
A-51	Marginal	66	48	57	Expansion in evaporation
A-60	Marginal	49	28	38	Density
B-4	Weak	25	6	15	Principle of telephone receiver
B-23	Marginal	43	39	41	Safety in thunderstorms
B-53	Weak	54	27	40	Volume of gas increases when pressure decreased
B-54	Marginal	69	48	58	Disposal of nuclear wastes

The overall rating for this goal was marginal at best, and the Panel's disappointment with the results led some panelists to question the physics background of junior secondary science teachers. Not unlike physics concepts, males' results were much better than females'. The difference was smallest for B-23 (Where is the safest place during a thunderstorm?) and largest for B-53:

B-53.

What happens to the balloon when the air in the bottle is extracted by a vacuum pump?



- *a) It increases in volume.
- b) It does not change in volume.
- c) It decreases in volume.
- d) It decreases in volume at first but then increases.
- e) It is sucked into its tube.
- f) I don't know.

p-values
Grade 12

40
10
19
5
11
12

4.3.4.9 Application: Earth/Space Science

The results for this goal are shown in Table 4.30.

TABLE 4.30

RESULTS FOR EARTH/SPACE SCIENCE APPLICATION: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-41	Weak	37	24	30	Uses of coal
A-59	Weak	49	26	37	Distances in the universe
B-32	Satisfactory	58	38	47	Effects of inclination of Earth's axis
B-44	Weak	36	22	24	Effects of over-logging
B-57	Marginal	40	33	37	Formation of igneous rocks
B-58	Weak	37	22	29	Geological time

The Panel rated these results as very poor performance, and concluded that Earth/Space Science is "the poor country cousin" in the junior secondary science curriculum in most schools. Item A-41 is illustrative of the results for this goal.

A-41.	
For which of the following can coal be used?	
KEY: 1. making chemicals	
2. making steel	
3. making electricity	
	<u>p-values</u>
	<u>Grade 12</u>
a) 1 only	12
b) 2 and 3	24
c) 3 only	18
*d) 1, 2 and 3	<u>30</u>
e) I don't know	15

4.3.4.10 Safety

Results on the five safety items are shown in Table 4.31.

TABLE 4.31
RESULTS FOR SAFETY: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-6	Very Satisfactory	91	92	92	Aid for person with clothing on fire
A-23	Marginal	72	53	62	Identification of flammable volatile liquids
A-54	Weak	69	35	52	Purpose of fuse or circuit breaker
B-29	Satisfactory	76	71	74	Heating liquid in test tube
B-30	Weak	34	28	31	Diluting acids
B-31	Very Satisfactory	84	83	83	Treatment for acid on skin

The Panel commented that their expectations were high but felt student performance was satisfactory. A comment was entered that in future assessments, safety in practical every-day situations should be tested.

4.3.4.11 Scientific Literacy

Twenty items were included under the heading scientific literacy. In addition to items of the type used in the grades 4 and 8 tests, two sets of items were included to assess students' ability to read and comprehend passages dealing with scientific matters. The results for scientific literacy are shown in Table 4.32.

TABLE 4.32
RESULTS FOR SCIENTIFIC LITERACY: GRADE 12

Item Number	Panel Rating	Percent Correct			Description of Items
		Male	Female	Total	
A-8	Satisfactory	84	83	84	What topic do scientists know everything about?
A-19	Satisfactory	66	54	59	Scientific status of astrology
A-20	Marginal	55	46	50	Connection between science and technology
A-21	Marginal	57	59	58	Relation between separate science disciplines
A-24	Satisfactory	60	58	59	Evaluation of statements based on reading of article on research in pulp and paper
A-25	Weak	26	18	22	
A-26	Very Satisfactory	79	76	77	
A-27	Weak	43	36	39	
A-46	Marginal	46	42	44	Identification of statement as hypothesis
A-56	Marginal	59	55	57	Evaluation of scientists' statements
B-19	Satisfactory	61	63	62	Verifiability of scientific reports
B-20	Weak	25	19	22	Meaning of scientific model
B-21	Strength	86	88	87	Willingness to consider evidence
B-24	Weak	43	36	40	Evaluation of statements based on reading of article on recombinant DNA
B-25	Very Satisfactory	72	75	74	
B-26	Satisfactory	62	62	62	
B-27	Weak	39	37	38	
B-28	Satisfactory	71	76	74	Stereotypes of scientists
B-48	Satisfactory	47	54	50	
B-49	Satisfactory	54	51	52	Relation between facts and theory

The Panel rated performance on scientific literacy as marginal, and called for more attention to be given in schools to developing interpretive skills. In fact, the ratings are satisfactory or better for more than half of the items, and the four weaknesses were recorded for the reading items (A-24 to A-27 and B-24 to B-28). Interestingly, for the reading items alone, the boys' results were slightly higher than the girls' (55 percent compared to 53 percent), although generally there was very little difference between boys' and girls' scores on the scientific literacy items. Notable exceptions were items A-19 (scientific view of astrology) and A-20 (relation between science and technology). On both items boys scored 9 percentage points higher than girls.

The marginal performance on item A-21 may reflect the way in which science is presented as separate disciplines at both the junior and senior secondary level.

A-21.

Are biology, chemistry, and physics related?

They are	<u>p-values</u> <u>Grade 12</u>
a) not related because they are built on different sets of fundamental principles.	9
*b) related because the observations, principles, and ideas of each field have connections with the other two.	<u>58</u>
c) related because mathematics serves to unify the sciences.	11
d) not related because biologists, chemists, and physicists study very different natural phenomena.	15
e) I don't know.	7

4.3.4.12 Summary

Considered as a whole, the grade 12 results must be considered to be disappointing to say the least, especially in light of the encouraging results of the grade 8 test. Apparently many students leave school with limited understanding of some very fundamental concepts. Also, the evidence indicates that during the secondary grades, the abilities to design and interpret experiments do not develop much beyond the level attained at grade 8. Perhaps this may relate to a finding from the teacher survey that secondary students spend most of their science classes doing experiments from instructions, and seldom design their own experiments. Another area of poor performance is knowledge of practical applications of science, possibly indicating an overemphasis on the formal theoretical aspects of science in the secondary grades. Finally, the very weak results obtained by girls in the areas of physics and earth/space science should give cause for concern. Present science offerings and teaching practices need to be investigated to determine to what extent the educational system is at fault in failing to teach girls important physical science concepts.

4.4 Group Differences: Grade 12

This section examines the grade 12 results for different categories of students according to the background questions on the tests. The data are presented in descriptive form, with background variables being considered separately. Cross-tabulations and regression analyses remain as worthwhile projects for future research.

4.4.1 Sex Differences

On the grades 4 and 8 achievement tests, clear differences were found between the results of male and female students. Differences on the grade 12 test were also found, and were even more pronounced.

On goals one, three, and four (concepts, applications, safety), males scored consistently higher than females except for those items dealing with reproduction and nutrition. On the other hand, for process skills and scientific literacy items, there was virtually no difference between males and females, which seems to indicate that the difference in achievement is not due to differences in science ability between boys and girls. Table 4.33 summarizes the differences for each goal at each grade level.

TABLE 4.33
COMPARISON BETWEEN
RESULTS OF MALES AND FEMALES: GRADES 4, 8 AND 12

Goal	Mean Percent Correct					
	Grade 4		Grade 8		Grade 12	
	Male	Female	Male	Female	Male	Female
Concepts	64	59	60	54	55	47
Process	76	76	63	63	47	47
Application	50	43	57	52	48	38
Safety	79	78	65	63	71	61
Scientific Literacy	46	44	60	62	57	55

Differences in achievement between male and female students are most clearly evident in the grade twelve results, particularly for the separate subject areas as shown in Table 4.34 on the following page.

TABLE 4.34
COMPARISON BETWEEN
RESULTS OF MALES AND FEMALES: GRADE 12

Subject	Mean Percent Correct			
	Goal 1 - Concepts		Goal 3 - Application	
	Male	Female	Male	Female
Bio'ogy	61	60	59	58
Chemistry	48	42	35	26
Physics	60	46	49	32
Earth/Space	50	39	42	27

Sex differences were apparent also in the choice of science courses in grades eleven and twelve. As can be seen from Table 4.35, the proportions of grade twelve male and female students who elected not to study science beyond grade ten does not differ greatly (34 percent of males versus 37 percent of females), but there is a clear tendency for girls to avoid physics - seventeen percent of the girls had studied physics in grade eleven or twelve, compared to 38 percent of the boys. Of the girls who had studied science in grade eleven or twelve, only 28 percent had studied physics; the corresponding figure for boys was 49 percent.

TABLE 4.35
NUMBER AND PERCENT OF GRADE TWELVE MALE AND FEMALE STUDENTS
TAKING SENIOR SECONDARY SCIENCE SUBJECTS

	Male	Female
Number of Students	(12,790)	(13,538)
No Science Courses beyond Grade 10	4,341 (34%)	4,957 (37%)
Some Senior Biology	5,808 (45%)	7,713 (57%)
Some Senior Chemistry	5,326 (42%)	4,789 (35%)
Some Senior Physics	4,857 (38%)	2,324 (17%)

The absence of sex differences on the process and scientific literacy goals was surprising, (see Table 4.33) and warrants further investigation. Sex differences on science achievement tests in favour of boys have

been well known for some time¹, but in this assessment, the sex difference was found to disappear for these two sets of items.

In the understanding concepts and application goals, girls actually achieved results superior to boys' on items dealing with nutrition, reproduction, and heredity. Boys achieved results superior to girls' on all other concept and application items, with the difference especially marked in physics. Possibly, the semantic content of the items may have contributed to the sex differences. This is an empirical question and warrants further study. The results for both males and females on every item in the tests are noted in the Appendix A; in themselves these results represent a source for educational research.

4.4.2 Science Courses Taken

In general, the students who had studied some science at the grade 12 level scored about ten percentage points higher, item by item, than the provincial average. The performance of students who had studied science at the grade 11 level but not at the grade 12 level reflected the provincial average. Table 4.36 presents these data goal by goal.

TABLE 4.36
GOAL SCORES (MEAN PERCENT CORRECT) IN GRADE 12
ACCORDING TO SCIENCE COURSES TAKEN IN GRADES 11 AND 12

Goal	Mean Percent Correct					
	No Science in Grades 11 or 12		Science in Grade 11 but not in Grade 12		Science in Grade 12	
	Male	Female	Male	Female	Male	Female
Understanding Concepts	43	37	53	46	68	59
Process	35	37	46	47	59	58
Application	36	29	46	37	59	48
Safety	64	55	71	61	79	66
Scientific Literacy	45	45	57	55	67	65

Students who reported that they had successfully completed or were currently taking physics in grades 11 or 12 generally scored about 12 percentage points above the provincial average. The difference was as high as 17 points for physics application. Moreover, those students who reported studying some science in grades eleven or twelve, but not physics, generally scored within one or two points of the provincial average. This pattern is illustrated in Table 4.37 on the following page.

¹See for example Maccoby E.A. & Jacklin, C.N. The Psychology of Sex Differences. Stanford: Stanford University Press, 1974.

TABLE 4.37
RESULTS OF PHYSICS STUDENTS AND
NON-PHYSICS SCIENCES STUDENTS: GRADE 12

Goal	Mean Percent Correct According to Courses Taken		
	Total for Province	Science, but no Physics in Grades 11 or 12	Physics in Grades 11 or 12
Understanding Concepts	51	52	66
Biology	61	64	72
Chemistry	45	46	67
Physics	53	51	68
Earth/Space	44	45	55
Process	47	50	59
Application	43	43	57
Biology	58	62	69
Chemistry	30	29	46
Physics	40	38	57
Earth/Space	34	33	47
Safety	66	66	76
Scientific Literacy	56	58	67

A similar pattern was observed for chemistry and non-chemistry students, while those who reported studying biology at the senior secondary level generally scored only about six percentage points above the provincial average. Clearly, physics students, and to a slightly lesser extent chemistry students, represent a very select group in the senior secondary grades.

The fact that physics and chemistry students represent a select group should be acknowledged and carefully considered when the senior secondary science offerings are reviewed. Such a review must consider the desirability of this apparent selectivity. If this situation is not seen to be desirable, then considerable changes would have to be made in the science course offerings at the senior secondary level to meet the needs and interests of a wider range of students.

4.4.3 Part-Time Employment

As a general rule, students who reported spending some time on a part-time job, but fewer than 10 hours per week, obtained results slightly above the provincial average (by one or two percentage points). Students who reported spending more than 20 hours per week on a part-time job obtained results slightly below the provincial average (by about three percentage points). The data are summarized in Table 4.38.

TABLE 4.38
RESULTS OF STUDENTS ACCORDING TO AMOUNT OF TIME SPENT
ON PART-TIME EMPLOYMENT: GRADE 12

Goal	Mean Percent Correct					Total Province
	No Part-Time Job	Less Than 5 hrs/wk	5-9 hrs/wk	10-20 hrs/wk	More Than 20 hrs/wk	
Concepts	51.6	53.1	52.7	51.0	48.7	51.1
Process	47.8	48.1	48.8	47.6	43.3	47.1
Application	42.8	44.2	44.0	42.2	40.6	42.5
Safety	65.6	66.9	67.0	66.4	65.7	65.7
Scientific Literacy	56.2	57.5	57.4	55.6	52.2	55.5

There is no evidence here to indicate that reasonable amounts of time spent on part-time employment affect science achievement to any great extent.

4.4.4 Parents' Education and Occupation

Students who reported that their fathers had completed university degrees obtained results much higher than the provincial average. The difference was more than nine percentage points on each goal except safety, in which case the difference was five percentage points. For other groups by fathers' education, the differences from the provincial average were relatively small (less than four percentage points).

These findings are shown in Table 4.39.

TABLE 4.39
RESULTS ACCORDING TO EDUCATION LEVEL
OF FATHER OR GUARDIAN: GRADE 12

Goal	Mean Percent Correct						University Degree
	Total for Province	Elementary	Junior High	Senior High	Trade or Vocational	Technical	
Concepts	51	49	49	51	53	55	61
Process	47	45	46	47	48	51	56
Application	43	40	41	42	45	46	52
Safety	66	64	65	66	68	68	71
Scientific Literacy	56	53	54	56	57	59	65

Similar results were found with respect to mothers' education, and to a slightly lesser extent, fathers' or mothers' occupation. The spread with respect to parental occupation was generally about six or seven percentage points, irrespective of whether male or female students, or mothers or fathers were considered. For example, on understanding concepts, boys whose fathers' occupations were classified as "managerial/professional" averaged 59 percent correct, while boys whose fathers' occupations were classified as "mining/logging/fishing/farm-work/unskilled" averaged 52 percent correct.

4.4.5 Homework

Students taking science who reported doing more science homework achieved higher mean scores on all goals as shown in Table 4.40.

TABLE 4.40
RESULTS OF SCIENCE STUDENTS ACCORDING TO MINUTES PER WEEK
SPENT ON HOMEWORK: GRADE 12

Goal	Mean Percent Correct				
	Minutes Per Week				
	0	30	30-60	60-90	90+
Understanding					
Concepts	43	56	59	62	65
Processes	36	52	55	57	59
Application	34	48	50	52	54
Safety	61	70	71	72	73
Scientific					
Literacy	45	60	63	65	67
N. Students					
Responding	2,028	1,584	2,634	2,374	4,692

Most students taking science in the senior secondary grades reported spending at least an hour per week on homework. This does not appear to be wasted effort.

4.4.6 Future Plans

For all goals except safety, a spread of more than twenty percentage points was found in the mean percent correct scores according to students' plans. For example, students planning to enter university averaged 64 percent correct on understanding concepts, while students planning to look for a job after leaving secondary school averaged 42 percent. The provincial average for this goal was 51 percent. Students planning to enter a technical institute or community college university transfer programme averaged 57 percent.

Results for students with various after school plans are shown in Table 4.41.

TABLE 4.41

RESULTS (MEAN PERCENT CORRECT)
ACCORDING TO STUDENTS' FUTURE PLANS: GRADE 12

Mean Percent Correct by Goals & Categories of Future Plans												
Goal	Total for Province	Look for a Job	Year off then Look for a Job	Business School	Vocational, Art, Trade	Community College Career	Year off then More Education	Community College, U-Trans.	Technical Institute	University	Other	Undecided
Concepts	51	42	43	43	46	48	53	57	57	64	47	48
Process	47	38	35	39	39	45	44	54	51	60	38	40
Application	43	34	31	38	38	38	36	48	48	55	31	32
Safety	66	61	63	65	63	63	67	69	71	73	64	65
Scientific Literacy	56	47	47	50	54	54	58	62	61	67	51	53
Number of Students	26,416	4320	316	509	2054	2117	3525	2570	1456	4475	2054	2464

Special interpretations using separate criteria were undertaken by the Contract Team in order to estimate the level of acceptability of the results for two of the groups: those students planning to enter university, and those students planning to look for a job.

The performance of the university-bound group was far more satisfactory than that of the work-bound group, even though higher criteria were set for the university group. Performance of the work-bound group was judged to be weak on more than half of the items, and satisfactory or better on about one-quarter. Performance of the university-bound group was judged to be very satisfactory or better on more than one-quarter of the items. The comparison is summarized in Table 4.42.

TABLE 4.42

INTERPRETATION BY CONTRACT TEAM OF RESULTS OF
STUDENTS PLANNING UNIVERSITY STUDY AND STUDENTS
PLANNING TO LOOK FOR A JOB: GRADE 12

Student Plans	Number of Items Judged by Contract Team to be				
	Weak	Marginal	Satisfactory	Very Satisfactory	Strong
University	33	28	28	24	7
Job	61	28	23	7	1

The weaknesses for the university-bound group were mainly in understanding physics concepts (5), chemistry application (5), and scientific literacy (6).

The weaknesses for the work-bound group were found in all goals, but were especially pronounced in understanding physics concepts (8), earth/space science concepts (7), chemistry concepts (6) chemistry application (7), and scientific literacy (8). Also for the work-bound group, no satisfactory or better ratings were found at all in chemistry application or earth/space science application.

In the judgement of the Contract Team therefore, the school system seems to be failing badly to provide a satisfactory education in science for those students who plan to complete their schooling at the end of grade 12.

4.5 Attitudes: Grades 7, 9, and 11

As described in Chapter 3, the attitudes instrument was designed by the Contract Team to be administered by teachers to a provincially representative sample of grade 7, 9, and 11 classes.

The instrument consisted of:

- 1) Semantic differential scales to measure attitudes towards science, scientists, and school science (Part A)
- 2) Personal action and hypothetical action scales to measure interests in science (Parts B and C)
- 3) Likert scales to measure students' attitudes towards science as a career, scientists, and scientific ideas (Parts D, E, and F).

On the semantic differential section (Part A), most students gave responses indicating favourable attitudes towards science, scientists, and science in school. The personal action scales (Parts B and C), indicated a low level of interest in most types of science-related activities on the part of 20 to 40 percent of the students. Part D indicated a general ambivalence about science as a career, while Parts D and E generally indicated a fairly realistic set of attitudes towards scientists and scientific ideas. Exceptions were a tendency to regard scientists as odd people and a reluctance to accept scientific views about astrology or the origins of life.

As a rule, differences according to sex or grade level were small, so the results are reported below for the sample as a whole. Atypically large differences are noted in the text.

4.5.1 Attitudes Towards Science, Scientists, and School Science (Part A)

The means and standard deviations for each of the seven point semantic differential scales are reported in Table 4.43 for each of the attitude objects. The higher the mean, the more favorable the attitude toward the stated object.

TABLE 4.43
ATTITUDE INSTRUMENT RESULTS
MEANS ON SEMANTIC DIFFERENTIAL SCALES (PART A)

Attitude Object	Mean	Standard Deviation
Scientist	5.6	1.0
Science	5.4	1.0
Doing Science Experiments	5.2	1.0
Science I Have Take in School	5.3	1.1
Industrialist	4.7	1.1
Reading Science Books	5.3	1.3
School	5.7	1.3

For all attitude objects except "industrialist", the means were at least one standard deviation above the midpoint of the scale. Although "school" and "scientists" shared similar ratings, "reading science books", "doing science experiments", and "science I have taken in school" all had ratings about one-third of a standard deviation lower than "school". Means for grade 9 students were generally about one-third of a standard deviation below the means for grade seven students (except for "industrialist"). Means for grade 11 students were close to the means for the grade 9 students except for "school", where the grade 11 mean was close to the grade 7 mean.

The attitude object "industrialist" evoked more unfavourable responses than the other objects, the mean being almost one standard deviation below that for "scientists" or "school". Figure 1 shows the trends in attitudes for each grade level.

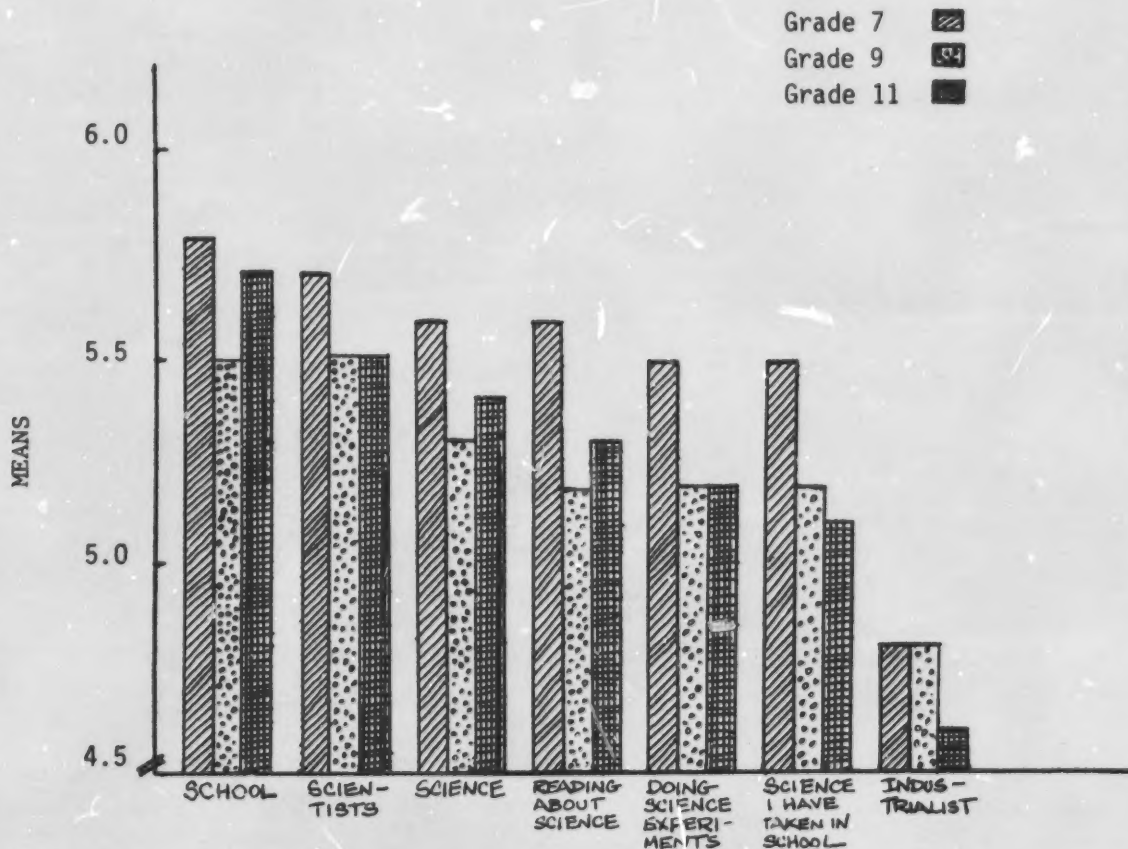


Figure 1

MEANS ON SEMANTIC DIFFERENTIAL SCALES
FOR GRADES 7, 9, AND 11

4.5.2 Interests in Science and Science-Related Activities

Part B of the attitude instrument (items 8 to 17) consisted of statements of a number of science-related activities. Students were required to respond on the following five-point scale:

1	2	3	4	5
Definitely Not Willing	Probably Not Willing to Try This Activity	Cannot Decide	Probably Willing to Try This Activity	Definitely Willing to Try This Activity

Results on this personal hypothetical-action scale are shown in Table 4.44. In the table, the five-point scale is summarized into three categories: "Not Willing" (categories 1 and 2), "Undecided" (category 3), and "Willing" (categories 4 and 5). More students were chosen from grade 11 than from either of the other two grades, therefore, the mean percents given in Table 4.44 are weighted to compensate for the uneven distribution of students by grade. The means were obtained by averaging the percent means for each grade.

TABLE 4.44
ATTITUDE INSTRUMENT RESULTS
WEIGHTED MEAN PERCENT RESPONSES TO PART B (SCIENCE INTERESTS)

Item Number	Statement	Weighted Mean Percent		
		Unwilling	Undecided	Willing
8.	Go to a movie having to do with science	23	20	58
9.	Enter a science fair	37	22	42
10.	Watch a science show on T.V.	21	19	60
11.	Do extra science experiments at home	49	18	33
12.	Take up a hobby having to do with science	31	29	40
13.	Read articles about science in a newspaper or magazine	28	20	51
14.	Find out how much I know in science compared to other students of my age in B.C.	39	20	43
15.	Take a test to find out whether I am suited to become a scientist	44	16	40
16.	Buy a book about science	52	22	26
17.	Take more science in school	42	21	37

In spite of the generally favourable attitude towards science indicated in Part A of the instrument, a large proportion of students indicated little interest in doing science experiments at home (item 11), buying books about science (item 16), or taking more science in school (item 17). On the other hand, more than half indicated interest in movies, television programmes, and newspaper or magazine articles about science (items 8, 10, 13).

Two findings of interest emerge from these data:

1) On any given item, from about one-quarter to one-half the students indicated lack of interest by responding in categories 1 or 2. About one-quarter responded in category 1 (definitely unwilling) for items 11, 16, and 17, which could be classed as school-type activities.

2) The three items for which interest levels were highest (8, 10, and 13) all relate to media presentations of science.

Teachers should be aware that such a large proportion of their science students appear to have a low level of interest in school-type science activities, and might consider capitalizing on the higher level of interest in media presentations of science.

Part C of the instrument (items 18 to 29) consisted of statements of science-related activities of the kind which might be expected to be part of science class activities. The following instructions were given:

How often have you done the things mentioned below, voluntarily, just because you wanted to, during the PRESENT SCHOOL YEAR? Do this by circling the appropriate number for each item. The scale is labelled as follows:

SCALE:	1	2	3	4	5
	Never	Rarely (once or twice)	A few times	Quite frequently	Very frequently

Results on this personal action scale are shown in Table 4.45.

As in Table 4.44, the five-point scale is collapsed into three categories by combining 1 with 2, and 4 with 5, and weighted means are given.

TABLE 4.45
ATTITUDE INSTRUMENT RESULTS
WEIGHTED MEAN PERCENT RESPONSES TO PART C (SCIENCE INTERESTS)

Item Number	Statement	Weighted Mean Percent		
		Never or Rarely	A Few Times	Quite or Very Frequently
18.	Applied scientific information to situations outside of school	57	30	13
19.	Listened to someone talk about science because I wanted to	48	31	21
20.	Thought about problems such as how the earth, the stars, or life came to be	16	24	60
21.	Tried to find out how mechanical things around the house work	29	26	45
22.	Talked to someone in school about things that interest me in science	54	29	17
23.	Tried to find out how some of the major industries in B.C. such as fishing, lumbering, and mining, apply scientific ideas	72	17	11
24.	Successfully carried out a scientific experiment which I designed myself	81	12	7
25.	Carried out an experiment from a set of instructions because I wanted to	58	22	17
26.	Copied science notes from the blackboard or overhead projector because I wanted to	48	21	31
27.	Talked to someone outside of school about things that interest me in science	56	24	20
28.	Memorized scientific information because I wanted to	58	21	21
29.	Read from a textbook in science because I wanted to	38	23	19

On most of the items, 40 to 50 percent of the respondents indicated a level of interest in science high enough to voluntarily engage in the activity at least a few times in the year. Almost half had frequently tried to find out how mechanical things around the house work (item 21), and 60 percent had frequently thought about the origins of the universe or of life (item 20). On the other hand, most students had never, or rarely,

designed and carried out an experiment for themselves (item 24), or tried to find out how major industries in the Province apply scientific ideas.

Chi-square analysis showed that the following differences were significant ($p < 0.01$):

1) About twice as many boys (60 percent) as girls (29 percent) reported trying to find out how mechanical things around the house work, quite frequently or very frequently (item 21).

2) More boys (35 percent) than girls (20 percent) reported trying to find out, at least a few times, how industries apply science (item 23).

3) More girls (73 percent) than boys (51 percent) indicated they had never successfully designed and carried out their own experiment (item 24).

4) More girls (43 percent) than boys (30 percent) indicated they had never voluntarily carried out experiments from sets of instructions (item 25).

5) The higher the grade level, the less likely students were to have carried out experiments for themselves (items 24 and 25). Table 4.46 illustrates this trend for item 24.

TABLE 4.46
GRADES 7, 9, AND 11 PERCENT RESPONSES
TO ATTITUDE INSTRUMENT ITEM 24¹

Grade	Percent Response in Category				
	Never	Rarely	A Few Times	Quite Frequently	Very Frequently
7	49	23	16	7	6
9	63	20	11	3	3
11	68	19	9	3	1

Teachers might well consider capitalizing on students' natural curiosity about origins and household gadgets (items 20, 21) and using these as a vehicle for stimulating interest in applications of science (items 18, 23).

¹
How frequently students successfully carried out a scientific experiment designed by themselves.

4.5.3 Interest in Science as a Career (Part D)

As described in Chapter 3, Part D was designed as a summative rating scale consisting of 13 Likert items. The means on the five-point scale for the three grade levels were:

Grade 7 = 3.3	(S.D. = 0.58)
Grade 9 = 3.1	(S.D. = 0.58)
Grade 11 = 3.2	(S.D. = 0.56)

These results indicate a certain amount of equivocation among students about careers in science. Means and standard deviations for each of the items are given in Appendix E. The results indicate that this scale could readily be developed for use as a measure of individual students' interest in science as a career.

4.5.4 Attitudes towards Scientists and Scientific Ideas (Part E)

As described in Chapter 3, Part E of the attitude instrument was planned as two summative rating scales consisting of Likert items, but the reliability coefficients for these 2 scales turned out to be unacceptably low (0.42 and 0.50 respectively). Therefore summative ratings are not reported here. Rather, the results are reported merely as responses to an opinion survey.

Means and standard deviations for each item are given in Appendix A. Table 4.47 shows the responses to each item collapsing the five-point scale to three intervals: disagree, undecided, agree. The figures in the table are weighted mean percents as in Tables 4.44 and 4.45.

TABLE 4.47
ATTITUDE INSTRUMENT RESULTS
WEIGHTED MEAN PERCENT RESPONSES TO PART E (SCIENTISTS AND SCIENTIFIC IDEAS)

Item Number	Statement	Weighted Mean Percent		
		Disagree	Undecided	Agree
43.	Scientists are usually odd compared with most people I know	23	23	54
44.	Scientists usually don't go along with things ordinary people like to do	23	23	54
45.	Scientists have the answers to most of the problems of our society	42	23	35
46.	Scientists practice a kind of magic	66	18	16
47.	Scientists put a high value on human life	14	33	53
48.	Scientists are right when they say that the planets do NOT determine success and failure in our daily lives	17	48	35

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Attitude Instrument Results Weighted Mean Percent Responses
to Part E (Scientists and Scientific Ideas) (Continued)

Item Number	Statement	Weighted Mean Percent		
		Disagree	Undecided	Agree
49.	Scientists should govern our country	77	19	4
50.	Scientists have done more harm than good in this world	65	24	11
51.	Scientists today know much more about the world than the scientists did a long time ago	6	7	87
52.	Scientists are right when they say that human life comes from simpler forms of life	17	40	43
53.	Scientific facts are usually true	12	27	61
54.	Scientific ideas can usually be proven by experiment	6	14	80
55.	Scientific ideas are usually too difficult to understand for most ordinary people	30	23	47
56.	Most scientific ideas of long ago are out-of-date because they are wrong	52	33	15
57.	Science is getting closer and closer to the truth	10	31	59
58.	Most scientific findings have been a blow against common sense	18	47	35
59.	Scientific progress and the progress of man go together	14	31	55
60.	Learning science makes you more broadminded	17	32	51
61.	All knowledge can be classified as either scientific knowledge or nonsense	55	29	16
62.	Science is the only answer to problems facing the people of the world today	56	24	20
63.	Scientific research should NOT get any of the taxpayers' money	59	26	15
64.	In everyday life science is NOT as practical as common sense	22	43	35

With respect to beliefs about scientists, students generally subscribed to the notion that scientists are somehow different or odd (items 43, 44), but agreed that scientists put a high value on human life (item 47), have done more good than harm (item 50), and know much more about the world today than in past years (item 51). Students disagreed that scientists practise a kind of magic (item 46), but were equivocal about whether scientists have the answers to society's problems (item 45), and disagreed that scientists should govern our country (item 49). Many students would neither agree nor disagree with scientists that human life comes from simpler forms (item 52), or that the planets do not determine success or failure in our daily lives (item 48).

With respect to beliefs about scientific ideas, responses generally seemed to display a fairly high level of faith in modern science (items 53, 54, 56, 57, 59, 62, 63). Students tended to feel that scientific ideas are very difficult (item 55), but that studying them makes people more broadminded (item 60). Even though many (55 percent) were not prepared to agree that science has a monopoly on valid knowledge (item 61), students were generally undecided about the relative merits of science and common sense (items 61, 64).

Although these findings seem to indicate a fairly realistic view of science on the average, some aspects seem worthy of more attention and discussion in schools. These include origins of the universe and life, astrology, the practical aspects of science, and the stereotype of the scientist as someone odd or different from other people.

4.5.5 Students' Views of Science Teaching Practices (Part F)

Part F of the attitudes instrument consisted of questions designed to determine students' perceptions of the kinds of science teaching practices to which they have been exposed. Some of the questions were similar to ones on the teacher questionnaires. These are discussed below, and also in Volume II of the General Report which deals with the teacher survey.

Results for Part F are given for the following categories of students:

- 1) Grade 7 students.
- 2) Grade 9 students.
- 3) Grade 11 students who had taken or were taking a senior secondary science class (grade 11 science students).
- 4) Grade 11 students who reported that they had taken or were taking Physics 11 (grade 11 physics students). They were instructed to respond in terms of their experiences in Physics 11.

- 5) Grade 11 students who reported that they had taken or were taking Chemistry 11 but not Physics 11 (grade 11 chemistry students). These subjects were instructed to respond in terms of their experiences in Chemistry 11.
- 6) Grade 11 students who reported that they had taken or were taking Biology 11 but not Chemistry 11 or Physics 11 (grade 11 biology students). They were instructed to respond in terms of their experiences in Biology 11.

4.5.5.1 Pattern of Required Science Class Activities

Students were given a series of descriptions of instructional practices, and asked to rate the frequency of the practices according to the following scale:

1	2	3	4	5	6
Never	Almost Never (Once or Twice During a Course)	Considerably Less Than Half of the Time	About Half of the Time	Considerably More Than Half of the Time	Almost Every Class

Percent responses on each interval of the scale for each item are given in Appendix E. Some of the more significant results were as follows:

	<u>Percent of Responses</u>
1) Many students reported being required to engage about half their time or more in such activities as	
a) doing experiments from sets of instructions	75
b) copying notes from blackboard or overhead projector	71
c) listening to teacher talk for most of the lesson	64
d) memorizing scientific information	53
e) doing problems from a book	53
f) reading from text books	53
g) doing worksheets	48
2) Many of the students reported that they:	
a) never have guest speakers in science	66
b) never go on field trips	58
c) never make up their own experiments in class	53
d) never do investigations at home	40
e) never discuss newspaper or magazine articles in class	38
f) never do projects or reports	30

Teacher-talk and recipe-book laboratory experiments are reported by students to be the most common science teaching practices in the Province. Teaching practices are discussed in more detail in Volume II of the General Report.

4.5.5.2 Perceived Difficulty of Science Courses

Students were asked to judge the difficulty of specific science courses using the following five-point scale:

1	2	3	4	5
Very Easy	Easy	Average	Difficult	Very Difficult

Means and standard deviations for each subject are given in Appendix C.

Table 4.48 shows, for each of five science courses, the percent of students at different grade levels who gave the responses "difficult" or "very difficult".

TABLE 4.48
PERCENT OF STUDENTS WHO RATED VARIOUS SCIENCE COURSES
AS "DIFFICULT" OR "VERY DIFFICULT"

Science Courses	Grade Levels of Students		
	Grade 7	Grade 9	Grade 11 Science Students
Physics 11	72	80	83
Chemistry 11	73	74	83
Biology 11	74	67	45
Earth Science 11	69	65	29
Science 10	71	51	10

Grade 7 students did not seem to anticipate that future science courses would be much more difficult than the one they were presently taking, but the grade 9 students anticipated that physics 11 and chemistry 11 would be more difficult than science 10.

Most of the grade 11 science students (83 percent) rated Physics 11 and Chemistry 11 as being "difficult" or "very difficult". By contrast, fewer than half rated Biology 11 or Earth Science 11 as "difficult" or "very difficult". This may explain in part the low enrolments in

senior secondary physics and chemistry by comparison with biology, and in turn the poor performances on the physics and chemistry sections of the achievement tests. Further investigation into the relationships among actual difficulty, perceived difficulty, enrolment, and achievement with respect to physics and chemistry seems warranted.

4.5.5.3 Homework Assignments

Students were asked to estimate how frequently they were assigned homework in a number of categories. They responded on the following six-point scale:

1	2	3	4	5	6
Never	Almost Never (Once or Twice During a Course)	Considerably Less Than Half of the Time	About Half of the Time	Considerably More Than Half of the Time	Almost Every Class

Results are summarized in Table 4.49. The mean percents in Table 4.49 are weighted in the same way as in Table 4.45.

TABLE 4.49
STUDENTS' ESTIMATES OF FREQUENCY OF ASSIGNMENT
OF DIFFERENT TYPES OF HOMEWORK

Item Number	Type of Homework	Weighted Mean Percent Responding in Each Category					
		1	2	3	4	5	6
97.	Problems at the end of a section	11	17	21	23	17	12
98.	Lab/experiment write-ups	15	12	15	18	22	18
99.	Do-at-home experiments	55	27	9	5	2	1
100.	Reading	8	17	25	24	16	9
101.	Preparing reports on topics in science	27	28	19	14	8	3
102.	Projects	31	28	17	10	8	5
103.	Preparing for tests	6	8	25	31	23	9
104.	Completing work unfinished in class	6	14	21	22	21	16

As might be expected, the higher the grade, the more frequently homework was assigned in most categories, but grade 7 students reported more frequent assignment of reports, projects, and do-at-home experiments than grade 9 or 11 students.

In grade 11, frequent assignment of end-of-chapter problems and completion of work unfinished in class was reported more often by the physics and chemistry students than by the biology students.

Since a wider variety of types of homework seems to be assigned in grade 7, the following comments are intended for secondary school science teachers. In general the homework pattern as reported by the students seems to be somewhat dull and unimaginative. Too much emphasis seems to be given to end-of-chapter problems, preparation for tests, lab write-ups, and completing work unfinished in class. Too little use seems to be made of reports, projects, or do-at-home experiments. Teachers might well consider alternative approaches to lab write-ups such as oral presentations of data or seminar-discussion approaches. Homework should be planned to complement class work rather than being a convenient way to allow for underestimation of time in planning classwork. Reports, projects, and do-at-home experiments or investigations can help stimulate interest, develop inquiry skills, and foster independence. Secondary science teachers might consider making more use of these types of homework assignments.

4.5.5.4 Students' Perceptions of Causes of Failure in Science

Students were presented with eight factors which may cause them to do poorly in science. They were asked to rate the importance of these in causing poor performance, using the following four-point scale:

1	2	3	4
No Importance	Slightly Important	Quite Important	Very Important

The results are summarized in Table 4.50 on the following page.

TABLE 4.50
STUDENTS' ESTIMATES OF IMPORTANCE OF FACTORS
IN CAUSING POOR PERFORMANCE IN SCIENCE

Factor	Rating of Factors			
	No Importance	Slightly Important	Quite Important	Very Important
Lack of interest	8	16	30	46
Quality of instruction	5	17	34	44
Difficulty in taking tests	5	21	44	29
Difficulty of science as a subject	7	21	40	32
Confusing instructions for experiments	8	24	40	29
Difficulty of texts	8	31	44	17
Weakness in mathematics	10	20	37	23
Weakness in writing ability	25	39	25	10

All factors except weakness in mathematics or writing were rated as "quite important" or "very important" by at least two-thirds of the students. Lack of interest and quality of instruction were rated as "very important" by close to half the students. Interestingly enough, these two factors were seen to be more important than any inherent difficulty of science as a subject.

Two aspects of the findings of the attitude instrument are worthy of special note:

- 1) Differences between boys and girls were small for most items on the instrument, but were large with respect to a few fairly specific attitudes or interests, such as belief in astrology, or interest in mechanical things and industrial applications. A productive line of research might be to identify the particular attitudes, beliefs, and interests on which boys and girls differ, and to relate these to differences in achievement.
- 2) For the most part, little variation in attitude or interest was observed between the grades 7, 9, and 11 samples. This may indicate that teaching in the secondary grades does little to change the attitudes and interests already developed in the elementary grades. Another possible explanation is that attitude is very resistant to school instruction and is more influenced by the media or peer culture. In that case it would be inappropriate to include development of attitudes and interests as goals of science teaching. Research is needed into the extent to which science teaching can influence students' attitudes and interests with respect to science.

4.6 Comparisons of Results with Other Populations

4.6.1 Basis for Comparison of Grade and Age Groups

Table 4.51 shows British Columbia and United States results for items which have been administered in both places.

Items from the National Assessment of Educational Progress are indicated as NAEP. Grade 12 results are compared with results for the American 17-year-old sample, or, in some cases, the adult sample. Grade 8 results are compared with the American 13-year-old sample. Grade 4 results are compared with the American sample of 9-year-old pupils.

Items from the International Study of Science Education in 19 Countries¹ are indicated as IEA. Grade 12 results are compared with the United States results for Population IV, which consists of all students in the terminal year of secondary school. Grade 8 results are compared with the United States results for Population II, which is defined as all students aged 14-0 to 14-11 years at the time of testing. The grade 4 results are compared with the results for Population I in the United States, which is defined as all students aged 10-0 to 10-11 years at the time of testing. Also given for IEA items is the mean percent correct for the 19 countries tested.

In some cases, the British Columbia results are compared with United States norms on standardized tests. The Cooperative Science Test norms shown in the table are from the Advanced General Science Form B.

4.6.2 Summary of Comparisons

The grade four results for British Columbia are consistently better than the American results with only one exception (Question 5: The nature of gravity). The consistency of this pattern reinforces the positive interpretation of the grade 4 assessment, although differences in the method of administering the tests may have contributed to the differences between the two sets of results. In British Columbia, but not in the United States, the children were given the test by their own teachers. Very possibly this contributed to the good scores obtained by our children.

For grades 8 and 12, the British Columbia results are generally comparable to those of the United States. This comparability seems to extend across all goals. In general, the weaknesses and strengths found in British Columbia occur also in the American sample. The general comparability does, however, indicate that discrepancies between the British Columbia and United States results are worth noting.

TABLE 4.51
B. C. SCIENCE ASSESSMENT RESULTS
COMPARED TO OTHER POPULATIONS

Goal	Item Number	B.C. Result	U.S.A. Result	Panel Rating ¹	Test	B.C. Performance Compared to U.S.A.
GRADE 4						
Understanding Concepts	1	90	82	ST	NAEP 72/73	Above
	2	74	67	S	NAEP 72/73	Above
	5	35	51	M	IEA	Below
	15	51	48	S	IEA	Comparable
	16	84	79	VS	NAEP 72/73	Above
	23	47	39	M	NAEP 72/73	Above
	30	86	39	ST	NAEP 72/73	Above
	34	96	90	ST	NAEP 72/73	Above
	36	73	62	VS	NAEP 72/73	Above
	47	63	62	S	IEA	Comparable
	48	79	66	VS	NAEP 72/73	Above
	50	96	86	ST	NAEP 72/73	Above
	54	44	41	VS	NAEP 72/73	Comparable
	68	87	82	VS	NAEP 72/73	Above
Observing	56	90	83	ST	NAEP 72/73	Above
Communicating	66	63	55	S	NAEP 72/73	Above
	67	96	91	ST	NAEP 72/73	Above
Measuring	13	71	66	S	NAEP 72/73	Above
Combined Process Skills	17	91	88	ST	NAEP 72/73	Comparable
	29	79	66	ST	NAEP 72/73	Above
	32	62	42	S	NAEP 72/73	Above
	52	66	68	VS	NAEP 72/73	Comparable
	58	67	61	VS	IEA	Above
Application	35	47	35	S	IEA	Above
	46	75	72	VS	IEA	Comparable
	65	72	59	VS	IEA	Above
Scientific Literacy	10	45	37	S	NAEP 72/73	Above
	43	24	25	M	NAEP 72/73	Comparable
	53	47	41	S	NAEP 72/73	Above

¹ Interpretation Panel ratings are abbreviated as follows:
W = weak, M = marginal, S = satisfactory, VS = very satisfactory,
ST = strength

Goal	Item Number	B.C. Result	U.S.A. Result	Panel Rating	Test	B.C. Performance Compared to U.S.A.
GRADE 8						
Understanding Concepts: Biology	A-27	41	49	W	NAEP 72/73	Below
	A-38	71	68	S	NAEP 72/73	Comparable
	B-31	42	51	M	NAEP 72/73	Below
	B-44	73	84	S	NAEP 72/73	Below
Chemistry	A-43	83	84	VS	IEA	Comparable (19 countries average 77)
Physics	A-10	34	54	M	Cooperative Sci.Test(Gr.8)	Below U.S. norms
	A-32	67	62	S	NAEP 72/73	Above
	B-2	65	62	S	NAEP 72/73	Comparable
	B-36	63	71	S	IEA	Below (19 countries average 52)
Earth/Space	A-25	25	26	W	NAEP 72/73	Comparable
	A-42	73	93	VS	NAEP 72/73	Below
	B-18	69	64	VS	NAEP 72/73	Above
	B-26	75	76	S	NAEP 72/73	Comparable
Measuring	A-41	59	42	S	IEA	Above (19 countries average 53)
Combined Skills	A-39	79	80	VS	NAEP 72/73	Comparable
Application	A-14	82	75	VS	NAEP 72/73	Above
	A-20	44	41	M	NAEP 72/73	Comparable
	B-9	22	35	M	Cooperative Sci.Test(Gr.8)	Below U.S. Norms
	B-25	55	51	S	NAEP 72/73	Comparable
	B-33	38	43	M	NAEP 72/73	Below
Scientific Literacy	A-7	79	75	VS	NAEP 72/73	Comparable
	A-34	69	68	S	NAEP 72/73	Above
	B-24	72	71	S	NAEP 72/73	Comparable

Goal	Item Number	B.C. Result	U.S.A. Result	Panel Rating	Test	B.C. Performance Compared to U.S.A.
GRADE 12						
Understanding Concepts: Biology	A-2	95	97	ST	NAEP 72/73	Comparable
	A-34	56	52	W	NAEP 72/73	Comparable
	A-52	53	55	M	NAEP 72/73	Comparable
	B-35	66	64	M	NAEP (Adult) 72/73	Comparable
	A-15	76	71	VS	Cooperative Sci.Test (Gr.9)	Comparable
Chemistry	A-50	50	51	M	NAEP 72/73	Comparable
	A-58	32	34	M	Cooperative Sci.Test (Gr.9)	Comparable
	B-16	77	84	VS	NAEP 72/73	Below
	B-36	21	27	W	IEA	Below (19 countries average 31)
	B-43	21	10	W	NAEP 72/73	Above
Physics	A-7	55	58	M	Cooperative Sci.Test (Gr.9)	Comparable
	A-33	69	60	S	Cooperative Sci.Test (Gr.9)	Above
	B-34	27	27	W	IEA	Comparable (19 countries average 31)
	B-37	51	60	M	Cooperative Sci.Test (Gr.9)	Below U.S. norms
Earth/Space	A-5	27	69	W	Dubins (Gr.9)	Below U.S. norms
	A-18	48	40	M	NAEP (Adult) 72/73	Above
	A-43	51	44	M	Dubins (Gr.9)	Above U.S. norms
	B-50	52	44	S	Dubins (Gr.9)	Above U.S. norms
	B-59	24	28	M	NAEP 72/73	Comparable
Combined Skills	A-36	43	46	W	IEA	Comparable (19 countries average 48)
Biology Application	B-18	48	48	M	NAEP (Adult) 72/73	Comparable
	B-51	15	15	W	NAEP 72/73	Comparable
Chemistry Application	A-55	29	31	W	IEA	Comparable (19 countries average 37)
	B-56	32	35	W	IEA	Comparable (19 countries average 45)

Goal	Item Number	B.C. Result	U.S.A. Result	Panel Rating	Test	B.C. Performance Compared to U.S.A.
GRADE 12 (Continued)						
Physics Application	A-47	56	59	M	IEA	Comparable (19 countries average 74)
Earth/Space Application	B-32	48	56	S	Cooperative Sci. Test (Gr. 9)	Below U.S. norms
Scientific Literacy	A-46	44	48	M	IEA	Comparable (19 countries average 41)
	B-21	87	78	ST	NAEP 72/73	Above

CHAPTER 5

**CONCLUSIONS, RECOMMENDATIONS
AND SUGGESTIONS FOR RESEARCH**

5.1 Conclusions and Recommendations

This section of the report consists of a number of conclusions arrived at after consideration of the results of the achievement tests, the attitudes questionnaire, and the teaching/learning survey. Thus, these conclusions and recommendations subsume information presented both in this volume and in Volume II (Teacher Survey). The conclusions give rise to twenty-one major recommendations. Discussion begins with the junior secondary level because it seems to present the most cause for concern.

The following evidence indicates problems in science education at the junior secondary level:

- a) The Interpretation Panel judged that performance was less than satisfactory for 70 percent of the items on the grade twelve achievement test, compared to 30 percent on the grade eight test, and 18 percent on the grade four test.
- b) There was no evidence that attitudes towards science generally, or as a school subject, become more favourable going from grade seven through eleven.
- c) Junior secondary science teachers frequently expressed a desire to teach other grades or other subjects.
- d) On completion of junior secondary science a large proportion of students avoid science courses in grades eleven and twelve.

A new junior secondary science curriculum is called for, and in the interim, the provision of a wider range of printed materials for junior secondary science.

We recommend:

1. *That the Ministry of Education establish immediately a curriculum revision committee to carry out a major revision of the junior secondary science program.*

This should be considered as the major recommendation of this report. Any new curriculum should be designed to appeal to girls as well as to boys, and should be adaptable to the wide ranges both of ability and interest in science at the junior secondary level. It should be designed to foster the development of skills in designing and interpreting experiments, and to help students relate science to current issues and practical applications.

We recommend:

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2. *That the Ministry of Education, as a priority item, increase the selection of texts and supplementary reading materials available to teachers of the present junior secondary science curriculum as long as it is in force.*

Other major concerns at the junior secondary level include the following:

- Many teachers are dissatisfied with the in-service programs available to them, and the lack of leadership at the district level.
- Many junior secondary teachers wish to teach other subjects or other grade levels. Teachers should be encouraged to develop special expertise in teaching science at the junior level. They should enjoy working conditions no less desirable than at the senior secondary level. In particular, large class size contributes to problems both of safety and morale. School districts might well examine the wisdom of concentrating inexperienced teachers at the junior secondary level.
- There is a lack of variety in methods for the teaching of science in the junior secondary grades. Teachers appear to need more time for preparation and marking, but too much time may now be taken up with marking student lab write-ups. Some of this time could be spent planning a greater variety of approaches to teaching science. Students in many secondary classes seldom or never engage in activities such as preparing reports, doing projects, designing their own experiments, or discussing current materials from newspaper and magazine articles. The routine of writing and marking reports on pre-arranged labs must be boring for both teachers and students.

We recommend:

3. *That school districts make efforts to foster and provide more in-service education for junior secondary teachers, especially in such ways as informal meetings of teachers, workshops conducted by teachers, and visits to other classrooms. University faculties of education could take the initiative in providing training for teachers in conducting in-service workshops.*
4. *That teachers widen their repertoire of methods of teaching science at the junior secondary level, and allocate some of the time now spent on routine marking of laboratory reports to planning different approaches.*
5. *That university faculties of education place more emphasis on the junior secondary level in science teacher education programs. Student teachers could be encouraged to specialize in teaching at that level by taking courses in a variety of science disciplines, studying the special needs and problems of adolescents, and concentrating their practice teaching in junior secondary grades.*
6. *That the B.C. Science Teachers' Association investigate the conditions of teaching science in the junior secondary grades, and explore ways to reverse the apparent trend that junior secondary science teaching is considered less desirable or less satisfying than senior secondary.*

7. *That school districts investigate the sizes of their junior secondary science classes and consider reducing large classes to levels compatible with the safety of students and decent working conditions for teachers.*
8. *That school districts designate, where this has not already been done, selected personnel to be secondary science co-ordinators.*

In the elementary schools, the results of the grade 4 achievement tests appear to be satisfactory, but a strong opinion is held by the Contract Team that there is a tendency to underestimate the science related abilities of elementary pupils. Another point of some concern is that differences in achievement between boys and girls, though small at grade four, are quite marked at the grade eight level in some areas of science. While it is recognized that cultural factors may be operating independently of the schools, elementary teachers should be aware of this trend in science achievement and should be encouraged to make efforts to counteract it.

Elementary teachers, in general, seem to be favourably disposed towards the new program, and although they seem to be working hard to provide science experiences for children, they need more support and encouragement in the forms of school and district leadership, better in-service, and increased availability of materials.

We recommend:

9. *That school districts and larger elementary schools designate selected personnel as elementary science co-ordinators where this has not already been done.*
10. *That school districts investigate the supply of science materials and equipment in their elementary schools and where necessary, take steps to increase the availability to elementary classroom teachers of good quality science materials and equipment.*
11. *That the Ministry of Education explore ways to assist districts in providing more and better science materials for use in conjunction with the elementary science programs.*
12. *That the Ministry of Education continue with the new elementary science program as outlined in the Interim Guide (1977), taking into consideration teachers' suggestions and ratings as described in the General Report.*
13. *That elementary teachers take active measures to stimulate the interest of girls in science, and to provide opportunities for children to exercise their thinking abilities in science.*

14. *That school districts make the effort to foster and provide more science in-service education for elementary school teachers, especially by way of informal meetings of teachers, workshops conducted by teachers, and visits to other classrooms.*

With respect to the senior secondary level, there is probably a connection between the low results on the grade twelve achievement test and the science courses offered and selected in the senior secondary grades. Girls tend to avoid science, especially physical science, in the senior grades. This tendency is reflected by the preponderance of men among senior secondary science teachers. Had girls achieved at the same level as boys on the science assessment, the results for the goals of understanding concepts, applications and safety would have been approximately five percent closer to the expectations of the Interpretation Panel.

Most senior secondary science teachers are satisfied with the present courses, except for complaints of lack of time, but there would appear to be many students whose needs are not being met through these courses. Most teachers favour the introduction of alternative courses for such students at the grade eleven level, but perhaps the present physics and chemistry courses could be revised or offered in a way that would appeal to more students, especially girls. Also, the low ratings given by the Interpretation Panel to the grade twelve results for process and scientific literacy indicate that these goals may need more attention in the secondary grades.

We recommend:

15. *That the Ministry of Education establish a committee to make a special study of the social and educational implications of the preponderance of males who are studying and teaching science in the secondary schools. The committee should conduct and sponsor research to determine if there are any factors within the school system which contribute to this situation, and which can be corrected. Further, they should suggest ways in which teachers can counteract factors operating outside the school system.*
16. *That the Ministry of Education and school districts give serious consideration to the introduction of more general science courses at the grade eleven level, as alternatives to or in place of the present courses, to meet the needs of a wider range of students.*
17. *That school districts explore ways to allocate more time to the present senior secondary science courses, especially where semester systems operate.*

18. *That teachers of science at both the junior and senior secondary levels make a conscious effort to promote the development of skills such as designing experiments and interpreting data, the ability to discuss intelligently the current issues related to science, and an appreciation of the nature and methods of science.*

The teacher questionnaire data indicate that there may be problems in many schools with respect to safety equipment, particularly with reference to eye wash stations, fire blankets, safety goggles, storage cabinets for dangerous materials, and fume hoods where these are necessary. In addition, many elementary teachers report inadequate working space, electrical and water supplies, numbers of sinks, and science preparation rooms.

We recommend:

19. *That the Ministry of Education establish safety standards for school science classrooms, and provide funds for school districts to conduct surveys of the science safety equipment in schools where science is taught and to correct deficiencies that may be discovered through the surveys.*
20. *That school districts take steps to provide elementary classrooms, where science is taught, with sinks, electrical outlets, flat-top tables or desks, storage space for equipment and student projects, and where space is available, to provide access to a science preparation room.*

Finally, many teachers expressed the need for additional background materials. A particular problem for teachers is keeping up to date on continuing developments of science, since university courses tend to concentrate on established academic science rather than on current issues.

We recommend:

21. *That the Ministry of Education undertake to publish a regular bulletin for teachers of science at all levels that would contain background material, science teaching tips, up-to-date information on developments in science, and discussion of science-related issues.*

5.2 Suggestions for Research

Many research questions can be answered with the data already collected in the assessment. The priorities of the science assessment were such that time did not allow some of the many possible questions to be addressed. A selection of such questions is listed below, and of course there are many others. The assessment data in itself represents a rich source for researchers.

Also, in the course of analyzing the data, many new questions emerged, and the relative importance of some issues in science education became more clear.

5.2.1 Junior Secondary Teaching-Learning Conditions

One of the 21 major recommendations of the assessment is for a study into the conditions of teaching science in the junior secondary grades. The basic question is why do so many junior secondary science teachers express the preference to teach at other levels? Class size, type of student, status of the position, the curriculum, career expectations of teachers, orientation of teacher education programs are some factors which could be examined.

5.2.2 Achievement

Why was the grade 12 Interpretation Panel so disappointed with the results when the grades 4 and 8 Panels were so pleased? Investigation could determine to what extent the expectations of the Panel were reasonable. The composition of the Panel is a factor which could be varied to determine to what extent a different "mix" of panelists might result in a different interpretation. The findings of the Contract Team that the results for the university-bound group of grade 12 students could be interpreted as being more satisfactory than results of the work-bound group, need further checking by independent panels.

An analysis of regression should be undertaken to estimate the relative effects of the different background variables on the achievement test results.

Another question of interest is to what extent does achievement on the assessment tests correlate with school science achievement?

5.2.3 Sex Differences

One of the 21 major recommendations of the assessment was for special investigation into the sex differences in enrolment in science courses, science achievement, and composition of the science teaching force. Some possible questions are:

- Why do girls avoid physical science?
- Do female elementary teachers communicate personal disinterest or insecurity in physical science to their female pupils?
- Do junior secondary science teachers, the vast majority of whom are men, communicate different expectations of success to their female students?

- To what extent do the curriculum and textbooks perpetuate the belief that girls have little interest or ability in physical science?
- What specific interests and attitudes differentiate most between males and females? How do these relate to achievement?
- To what extent did the content of particular test items contribute to the sex difference in achievement?
- Do boys perform better than girls on tests of reading with science content?

5.2.4 Attitudes

What is it about science as portrayed by the media which interests students more than school activities? Specific investigation into this question might provide clues to ways of improving teaching practices.

Another aspect of the findings of the attitude instrument which merits further study is the apparent lack of interest among students in industrial applications of science.

The perceived difficulty of chemistry and physics also seems worthy of further study, together with its relationship to achievement, and the science background of teachers.

The question of the extent to which schools do or can influence attitudes and interests with respect to science also deserves attention.

5.2.5 Homework

Many questions remain to be answered with respect to homework. Students who reported doing more homework achieved higher scores on the tests. Is this a causal relationship? What kinds of homework are these students doing -- the routine "finish it at home" type described by many on the attitudes instrument, or independently guided study?

5.2.6 Detailed Study of Apparent Weaknesses

The scope of the assessment allowed coverage of only a few objectives for a limited number of goals. Some of the apparent weaknesses in the results deserve individual study, using larger numbers of items than two or three. For example, students' understanding of photosynthesis could be investigated using a single test with a more complete selection of items. Interviews with individual students, or small groups of students, might help clarify the difficulties students had on some of the multiple-choice items on the grades 4 and 8 tests.

5.2.7 General

This report should not represent the final work on the data generated by the science assessment. The Contract Team hopes that opportunities will be created for Ministry personnel, university researchers, education students, school boards, teacher groups, and individual teachers both to further analyze the existing data and to carry out follow-up research.

APPENDIX A
THE ACHIEVEMENT TESTS

The five achievement test booklets are reproduced in this appendix. There is a handwritten summary of the results included for each item

- the correct response is indicated by an * to the far left of the item options.

- to the left of each response choice is the percent of students at the appropriate grade level who selected that response

- to the right of every item, the percent correct is given for males (M=50) and females (F=50)

- also at the right, is the performance rating (s) given to each item by the Interpretation Panel

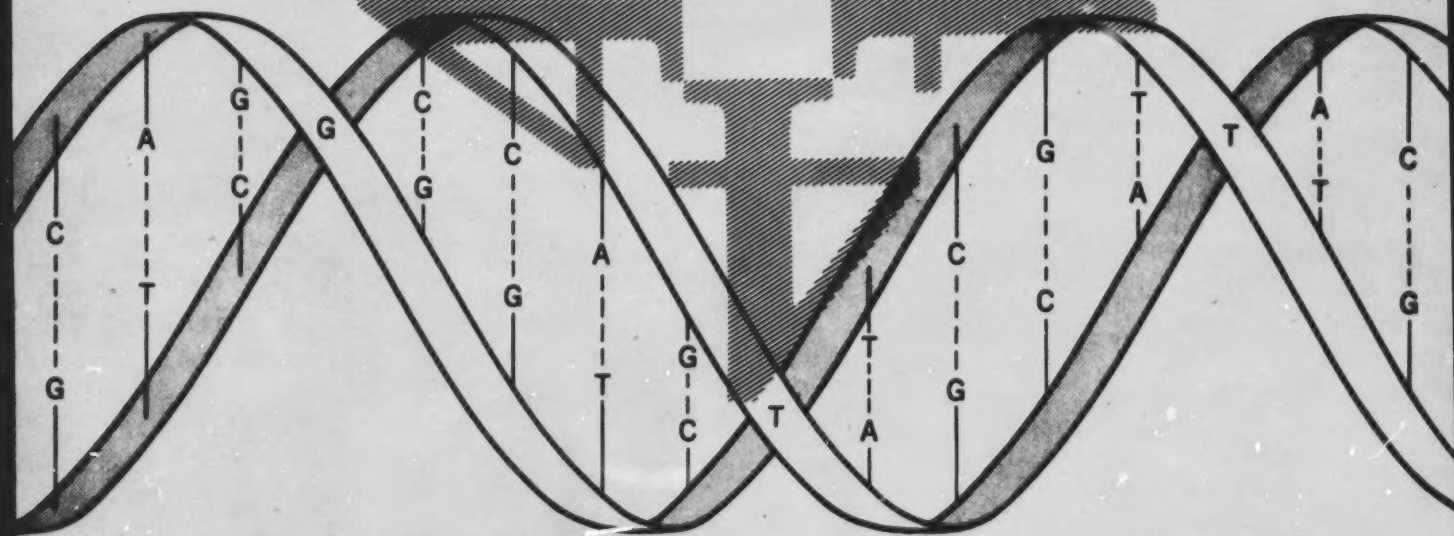
The following code was used for rating:

W	=	weak
M	=	marginal
S	=	satisfactory
VS	=	very satisfactory
ST	=	strength

**SCIENCE
ASSESSMENT**

GRADE / YEAR

4



GRADE/YEAR 4 SCIENCE

BACKGROUND INFORMATION

1. Please write your school code number in the box.

(16-18)

2. Are you a boy or a girl?

Boy

☐ 1

(11)

Girl

☐ 2

3. How old are you today?

8 years of age

☐ 1

(12)

9 years of age

☐ 2

10 years of age

☐ 3

11 years of age

☐ 4

more than 11 years of age ☐ 5

4. When were you born?

Month: January

☐ 01

(13-14)

February

☐ 02

March

☐ 03

April

☐ 04

May

☐ 05

June

☐ 06

July

☐ 07

August

☐ 08

September

☐ 09

October

☐ 10

November

☐ 11

December

☐ 12

5. Day

(15-16)

STOP! WAIT FOR YOUR TEACHER TO READ THE

INSTRUCTIONS

For each question, select the one best answer and mark a "✓" in the box opposite your answer. If you have no idea of the correct answer, place your mark in the box that shows "I don't know." Try this example:

How many months are there in a year?

10

☐ 1

12

☐ 2

24

☐ 3

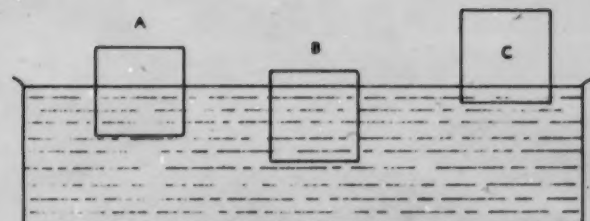
52

☐ 4

I don't know

☐ 5

DO NOT BEGIN UNTIL YOUR TEACHER TELLS YOU TO DO SO.



1. The three solid objects shown above are the same size. If they float as shown, which one weighs the most?

1 Object A

☐ 1 A=11 (17)

2 Object B

☐ 2 F=22

3 Object C

☒ 3

4 They all weigh the same

☐ 4

5 I don't know

☐ 5

2. Each year the Earth moves once around

1 Mars

☐ 1 M=11 (18)

2 Saturn

☐ 2 S=20

3 the Sun

☒ 3

4 the Moon

☐ 4

5 all of the other planets

☐ 5

6 I don't know

☐ 6

3. Which would be easiest to measure with a metric ruler that is 30 cm long?

1 The length of a pencil

☐ 1

2 The thickness of a sheet of paper

☐ 2

3 The distance from your home to the school

☐ 3 M=11

4 The distance from your home to the nearest grocery store

☐ 4 F=20

5 I don't know

☒ 5

All of the leaves in the first row are DICOTS



oak



strawberry



maple



rose

All of the leaves in the second row are MONOCOTS



lily



corn



plantain



bulrush

ONE of the leaves in the third row is a monocot



dogwood

A



pondweed

B



aspen

C



geranium

D

4. Which leaf is a monocot?

- 5 A ☐ 1 (20)
 13 B ☐ 2 M=73
 8 C ☐ 3 F=15
 6 D ☐ 4 1/2
 7 I don't know ☐ 5

5. When Tom threw his rubber ball into the air, it came back to the ground because

- 13 the air pushed it back
 18 rubber always bounces back
 35 the earth pulled it back
 21 the air is very light
 11 the earth is a large magnet
 2 I don't know

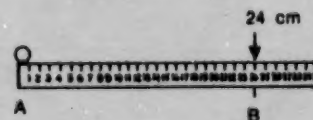
- ☐ 1 M=41 (21)
☐ 2 F=27
☒ 3 M=6
☐ 4
☐ 5
☐ 6

6. Which of these are pictures of living things?

bicycle
Aplant
Bgoldfish
Cwatch
Dmountain
E

- 1 A and B ☐ 1 (23)
 2 A and C ☐ 2 M=95
 95 B and C ☐ 3 F=95
 1 A, D, and E ☐ 4 57
 0 I don't know ☐ 5

7. The picture below shows a marble and a ruler. If the marble rolls from A to B in 2 seconds at a steady speed, how fast is it going?



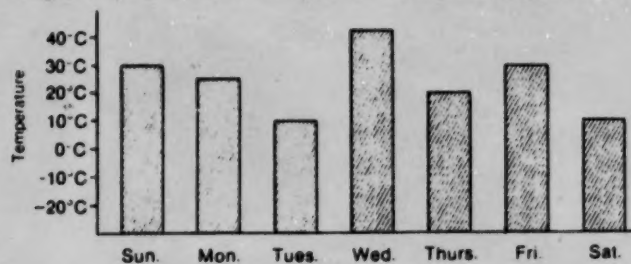
- 24 12 cm per 2 seconds ☐ 1 M=33 (23)
 25 24 cm per second ☐ 2 F=28
 8 24 mm per second ☐ 3 57
 2 240 mL per second ☐ 4
 3 12 cm per second ☐ 5
 11 I don't know ☐ 6

8. In many parts of British Columbia, a noon temperature of 2°C is most likely in

- ☐ 56 January.
☐ 13 May.
☐ 12 June.
☐ 11 July.
☐ I don't know.

- ☐ F=56 (24)
☐ M=56
☒ J=56
☐ 4
☐ 3

The highest temperature recorded each day for a week is shown on the graph below.



9. Which of the following statements is correct?

- ☐ 1 Monday had the lowest temperature
☐ 3 Highest temperature was recorded on Thursday
☐ 7 It snowed on Tuesday
☒ 8 On Wednesday the temperature was higher than on Sunday
☐ 7 I don't know

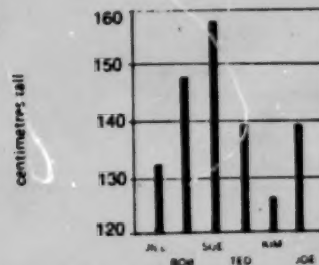
- ☐ 1 (25)
☒ M=80
☐ F=81
☒ VS

10. Some children were trying to find out which of three light bulbs was brightest. The children said the following things. Which of these gives the best start toward finding the answer?

- ☐ 14 One bulb looks brightest to me so I already know the answer
☐ 14 All the bulbs look bright to me so there can't be an answer
☒ 15 It would help if we had a way to measure the brightness of a light bulb
☐ 20 Let's take a vote, each person will vote for the bulb he thinks is the brightest
☐ 7 I don't know

- ☐ 1 (26)
☒ M=45
☐ F=45
☒ S

11. This is a graph of how tall 6 children are (in centimetres). Which child is shortest?



- ☐ Jill
☐ Bob
☐ Sue
☐ Ted
☒ Kim
☐ I don't know

- ☐ 1 (27)
☒ M=99
☐ F=99
☒ S

12. Look at the graph again. Which two children are the same height?

- ☒ 9 Ted and Joe
☐ 1 Sue and Ted
☐ 0 Jill and Kim
☐ 0 Jill and Bob
☐ 0 I don't know

- ☐ 1 (28)
☒ F=98
☒ S

13. If you want to find out how much a person grew in one year, which of the following MUST you know about the person?

- ☐ 11 His age
☐ 11 The type of food he eats
☒ 7 His height at the start of the year
☐ 4 The height of his mother and father
☐ 2 I don't know

- ☐ 1 (29)
☒ M=64
☐ F=74
☒ S

14. Which of the following have probably been on Earth the shortest time?

- ☐ 13 Alligators
☐ 18 Dragonflies
☒ 6 Fish
☐ 45 Men
☐ 13 Snails
☐ 7 I don't know

- ☐ 1 (30)
☒ F=40
☒ S

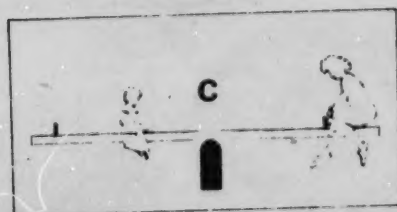
15. Betty wanted to balance on the teeter-totter with her little brother. Which is the best way for them to sit?



17 A (31)



12 B ☐ =



19 C ☐ =



51 D ☐ =

1 I don't know ☐ =
M=53
F=48
S

16. It is most likely to snow when the weather is

- 1 warm and clear
2 warm and foggy
3 cold and clear
4 warm and cloudy
5 cold and cloudy
6 I don't know

☐ 1 M=84 (32)
☐ 2 F=63
☒ 3 VS
☐ 4
☐ 5
☐ 6

17. Alice has a flat tire on her bicycle. She pumps up the tire with an air pump and begins to ride. In a few minutes, the tire is flat again. To fix her tire, Alice must find

- 1 a better air pump ☐ 1 (33)
2 whether the tire is made of rubber ☐ 2 M=92
3 where the air leaks out of the tire ☐ 3 F=90
4 how many minutes it takes the tire to go flat ☒ 4 S
5 I don't know ☐ 5

Look at the picture.



18. Which choice tells all that you can see in the picture and no more?

- 80 A hand is holding a match which is burning and giving off smoke ☐ 1 (34)
3 Someone has just lit a match ☐ 2 M=80
11 A hand is holding a burning match ☐ 3 F=79
6 Someone is about to be burned by the match he is holding ☒ 4 VS
1 I don't know ☐ 5

19. Three teaspoons of salt were mixed into a glass of water. How could you get back all the salt?

- 36 Pour the water through a fine paper filter ☐ 1 M=24 (35)
2 Use a magnet on the liquid ☐ 2 F=18
21 Boil the liquid until all the water is gone ☒ 3 M
34 Let the liquid stand overnight so that all of the salt goes to the bottom ☐ 4
7 I don't know ☐ 5



A

B

C

D

20. Which container has a sign which means THIS COULD POISON YOU?

- 1 A ☐ 1 (36)
 3 B ☐ 2 M=84
 4 C ☒ 3 F=79
 14 D ☐ 4 S
 0 I don't know ☐ 5

21. Which container has a sign which means THIS CONTAINER MAY EXPLODE?

- 11 A ☐ 1 (37)
 11 B ☐ 2 M=89
 1 C ☐ 3 F=87
 0 D ☐ 4 S
 0 I don't know ☐ 5

22. Which container has a sign which means THIS CAN HURT YOUR SKIN AND EYES?

- 5 A ☐ 1 (38)
 3 B ☐ 2 M=80
 15 C ☐ 3 F=74
 77 D ☒ 4 S
 1 I don't know ☐ 5

23. Which of the following dissolves LEAST in water?

- 47 Glass
 13 Salt
 19 Soap
 14 Sugar
 4 I don't know

- ☐ 1 M=45 (39)
☐ 2 F=47
☒ 3 A
☐ 4
☐ 5

24. The caterpillar is an early stage in the life history of a

- 2 fly.
 1 bee.
 6 grasshopper.
 8 butterfly.
 3 mosquito.
 3 I don't know

- ☐ 1 M=85 (40)
☐ 2 F=86
☒ 3 S
☐ 4
☐ 5
☐ 6

25. You could measure the distance from your home to the school in

- 4 dozens.
 78 metres.
 10 grams.
 4 litres.
 4 I don't know

- ☐ 1 M=80 (41)
☐ 2 F=75
☒ 3 S
☐ 4
☐ 5

26. Germs sometimes make people sick because germs

- 42 make poisons.
 3 keep the blood from moving.
 20 use up all of the water in the body.
 7 don't like people and want to hurt them.
 8 I don't know

- ☐ 1 M=44 (42)
☐ 2 F=39
☒ 3 S
☐ 4
☐ 5

A class decided to show the temperature with the following shapes:

- Circle ○ for over 20°C
Diamond ◇ for 10° to 20°C
Triangle △ for 5° to 10°C

27. If the temperature at noon on Thursday is 7°C, which shape should be used?

- 6 ○ ☐ 1 (43)
9 ◇ ☐ 2 $M=79$
10 △ ☐ 3 $F=80$
5 I don't know ☐ 4 (S)

On each of three days the temperature at noon was:

Monday 23°C Tuesday 22°C Wednesday 12°C

28. Which of the following shows the temperatures at noon for the three days?

- | | Mon. | Tue. | Wed. | | |
|----|------|------|--------------|----------------------------|---------------------------|
| 1 | ○ | ◇ | △ | ☐ 1 | (44) |
| 12 | ○ | ○ | △ | ☐ 2 | $M=41$
$F=91$
(S) |
| 14 | ○ | ○ | ◇ | ☐ 3 | |
| 7 | ◇ | ◇ | △ | ☐ 4 | |
| 20 | | | I don't know | ☐ 5 | |

A doctor kept records of breathing rates of people when they were resting. He made the chart below.

BREATHING RATES

Persons	Breaths in a minute
Baby boys	36
7-yr.-old girls	25
7-yr.-old boys	25
10-yr.-old boys	20
Mothers	16

29. This chart suggests that

- 1 boys breathe faster than girls ☐ 1 (45)
2 girls breathe faster than boys ☐ 2 $M=78$
3 older people breathe faster than younger people ☐ 3 $F=81$
4 younger people breathe faster than older people ☐ 4 (S)
5 I don't know ☐ 5

30. The bones of dinosaurs that lived millions of years ago can be found in the

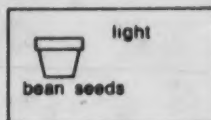
- 10 ocean water ☐ 1 $M=90$ (46)
0 ice on a pond ☐ 2 $F=82$
1 trunks of trees ☐ 3 (S)
1/4 rocks in the ground ☐ 4
2 I don't know ☐ 5

31. Here is a picture of 4 objects. Which of the objects are the SAME?



- 1 1 and 4 ☐ 1 (47)
2 2 and 3 ☐ 2 $M=94$
3 1, 2, and 4 ☐ 3 $F=96$
4 2 and 4 ☐ 4 (S)
5 I don't know ☐ 5

Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and a pot with 6 bean seeds on the window sill.

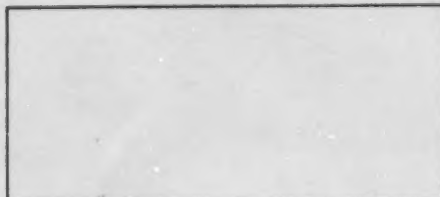


He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grew best in the light.

32. To be able to say this, Tom should have

- 7 watered both pots more. ☐ 1 M=1 (48)
- 14 watered the radish seeds more. ☐ 2 F=6
- 62 put the same kind of seeds in both pots. ☐ 3 S
- 6 grown the seeds in water instead of soil. ☐ 4
- 9 I don't know. ☐ 5

33. Use the ruler provided to measure the LONG side of this rectangle.



- The length is
- 3 11 centimetres. ☐ 1 (49)
 - 12 10 centimetres. ☐ 2 M=83
 - 13 9 centimetres. ☐ 3 F=21
 - 1 8 centimetres. ☐ 4 S
 - 1 I don't know. ☐ 5

34. Which of the following is the SUREST sign that a dog is sick?

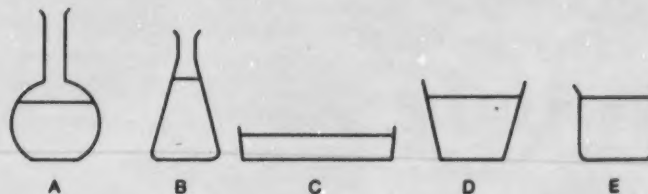
- 1 Its fur is clean. ☐ 1 M=95 (50)
- 1 It sleeps at night. ☐ 2 F=96
- 1 It is very playful. ☐ 3 ST
- 96 It has not eaten its food for two days. ☐ 4
- 1 I don't know. ☐ 5

35. The reason milk kept in a refrigerator does not go sour quickly is that the cold

- 7 changes the water of the milk into ice.
- 30 separates the cream.
- 67 slows down the action of bacteria.
- 3 keeps flies away.
- 11 causes a skin to form on the surface.
- 12 I don't know.

- ☐ 1 (51)
- ☐ 2 M=97
- ☐ 3 F=96
- ☐ 4 S
- ☐ 5

36. A litre of water is poured into each of the containers shown below and they are left uncovered in a warm room. After a day, which container will have the LEAST amount of water left in it?



- 8 Container A. ☐ 1 M=74 (52)
- 9 Container B. ☐ 2 F=71
- 13 Container C. ☐ 3 S
- 4 Container D. ☐ 4
- 2 Container E. ☐ 5
- 4 I don't know. ☐ 6

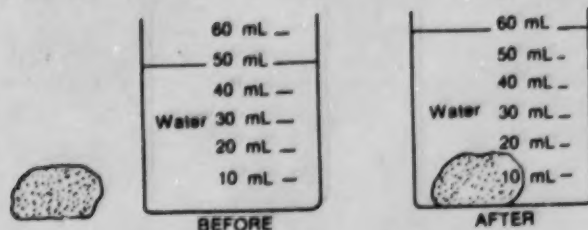
STOP

WAIT FOR INSTRUCTIONS.

SCIENCE ASSESSMENT — GRADE/YEAR 4

PART 2

A tiny rock is put into a measuring cup that has some water in it. Before the rock is put into the cup, the water is at the 50 mL line. After the rock is added, the water rises to the 60 mL line.



37. The space taken up by the rock is

- 78 10 mL ☐ 1 (53)
- 3 50 mL ☐ 2 M=81
- 15 60 mL ☐ 3 F=76
- 1 110 mL ☐ 4
- 3 I don't know ☐ 5 (VS)

38. Seeds come from which one of the following parts of a plant?

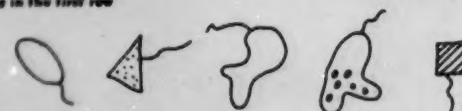
- 51 Flower ☐ 1 M=51 (54)
- 6 Leaf ☐ 2 F=52
- 12 Root ☐ 3 (M)
- 8 Stem ☐ 4
- 2 I don't know ☐ 5

39. If all green plants died, what would be the most important effect on man?

- 12 He would have to eat meat only ☐ 1 (55)
- 20 Sooner or later man would die of starvation ☐ 2 M=81
- 43 Man would get a little sick because he couldn't get vitamins ☐ 3 F=10
- 7 Man couldn't build houses because there would be no lumber ☐ 4 (M)
- 11 The land would be bare and not very pretty for man to look at ☐ 5
- 6 I don't know ☐ 6

Look at the imaginary tiny animals below.

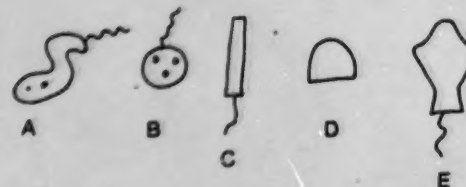
Wibbles look like those in the first row



but none of those in the second row is a Wubble.



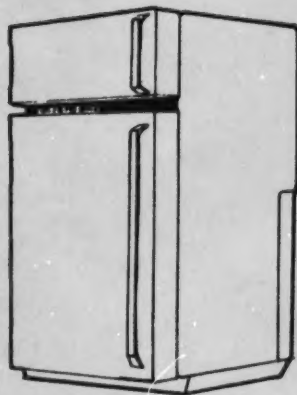
40. Which one in the third row is NOT a Wubble?



- 2 A ☐ 1 (54)
- 4 B ☐ 2 M=74
- 12 C ☐ 3 F=76
- 75 D ☐ 4 (VS)
- 3 E ☐ 5
- 3 I don't know ☐ 6

41. What is the MOST important thing that the lungs do?

- 1 Hold the chest out ☐ 1 M=68 (57)
- 4 Protect against germs ☐ 2 F=63
- 3 Move different parts of the body ☐ 3 (6)
- 23 Pump the blood through the body ☐ 4
- 65 Provide a place for oxygen to enter the blood ☐ 5
- 4 I don't know ☐ 6



42. What will happen to the balloon if it is left in the refrigerator?

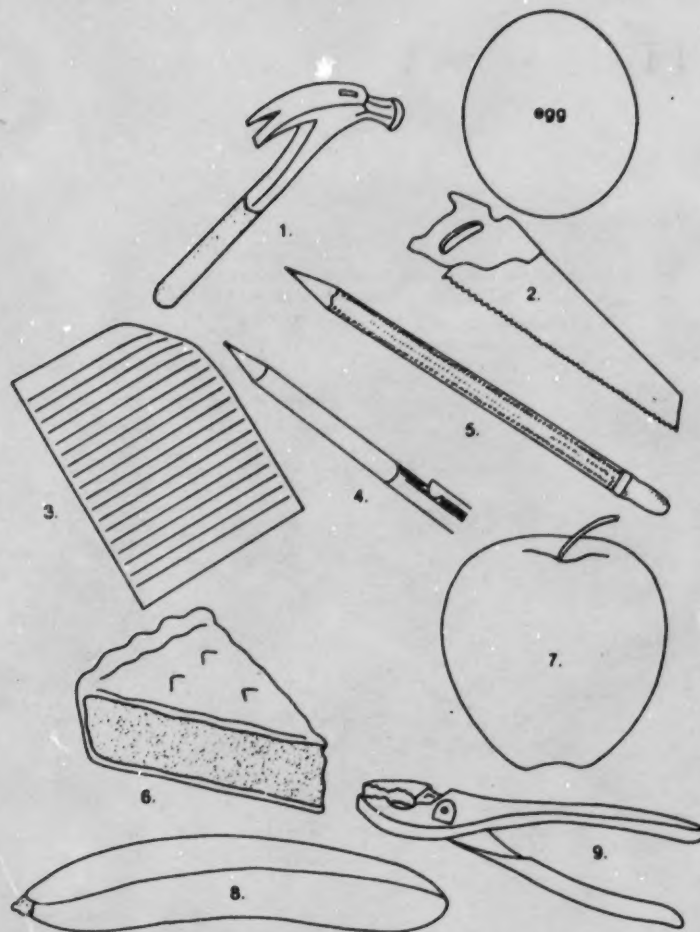
- ☐ 1 The balloon will crack
☐ 2 The balloon will get bigger
☒ 3 The balloon will stay the same
☐ 4 The balloon will get smaller
☐ 5 I don't know

43. About what topic do scientists know everything?

- ☐ 1 Clouds
☐ 2 Stars
☐ 3 Trees
☒ 4 No topic
☐ 5 I don't know

44. You could measure how heavy you are in

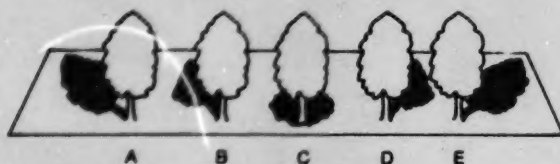
- ☒ 1 kilograms
☐ 2 litres
☐ 3 kilometres
☐ 4 millilitres
☐ 5 I don't know



45. To which set of drawings does the egg belong?

- ☐ 1 1, 2, 9
☐ 2 1, 3, 4, 5
☒ 3 6, 7, 8
☐ 4 1, 4, 5, 8
☐ 5 I don't know

At different times during a sunny day, a tree was seen to have cast a shadow of different lengths as shown in the diagram below.



46. Which diagram shows the shadow at midday?

- ☐ 1 A (62)
☐ 2 B
☐ 3 C
☐ 4 D
☒ 5 E
☐ 6 I don't know

47. Look at the diagrams below. To make the flashlight work, which way must we place the batteries?



63 ☐ 1 (63)



21 ☐ 2



I don't know...

10 ☐ 3

2 ☐ 4

M=76
S=46
S

20

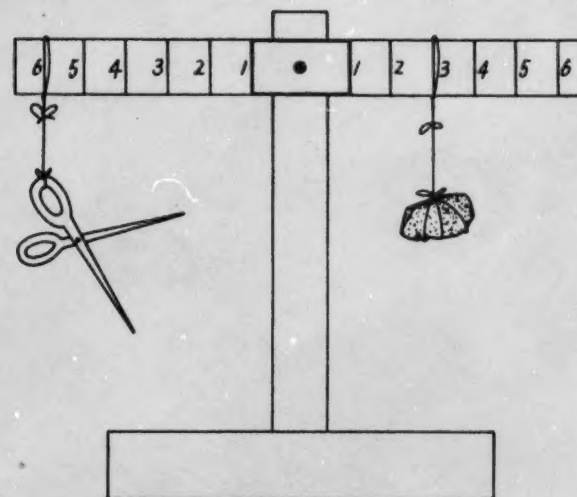
146

48. Iron is most likely to rust when it is

- ☐ 1 damp
☐ 2 dry
☐ 3 painted
☐ 4 covered with soap
☐ 5 covered with grease
☐ 6 I don't know

☐ 1 M=81
☐ 2 F=78
☒ 3 M=78
☐ 4
☐ 5
☐ 6

Look at the picture carefully.



49. From the picture you can say that

- ☐ 1 the scissors and the rock weigh about the same.
☐ 2 the scissors weigh about two times as much as the rock.
☒ 3 the rock weighs about two times as much as the scissors.
☐ 4 the rock weighs about three times as much as the scissors.
☐ 5 I don't know

☐ 1 M=20
☐ 2 F=16
☒ 3 M=16
☐ 4
☐ 5

21

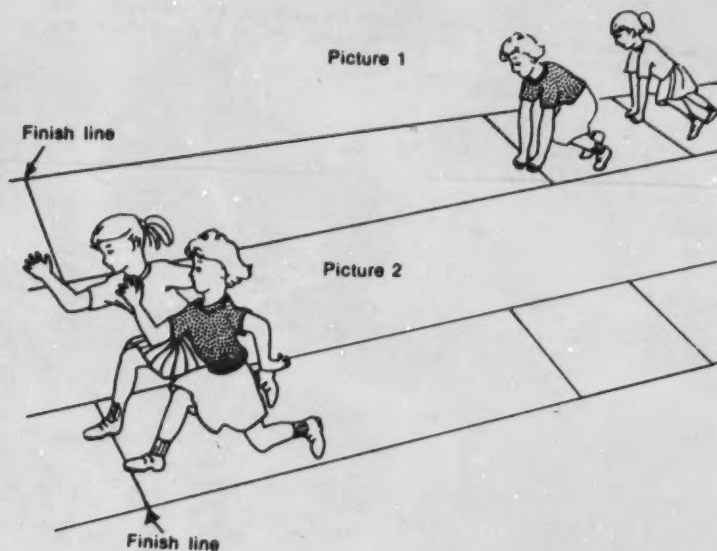
147

50. Which of the following COULD cause a rainbow?

- 1 Fog and smog
2 Rain and snow
3 Clouds and ice
4 Sunshine and rain
5 I don't know.

☐ M=9966
☐ F=96
☒ ST
☐ *

Look at Pictures 1 and 2 carefully. Picture 1 is a picture of two girls at the beginning of a foot race. Picture 2 is a picture of the girls as they cross the finish line.



51. Who ran more SLOWLY?

- 1 The girl in the white T-shirt
2 The girl in the dark T-shirt
3 They were both travelling at the same speed
4 I don't know.

☐ M=66 (67)
☐ F=66
☐ F=61
☒ VS

22

52. Someone said that if you mix salt and sugar with water and let the mixture stand, you get saltwater taffy—a kind of candy. Which of the following would be the best way for you to test this idea?

- 3 Take a vote among your friends
11 Buy some saltwater taffy and see if it has salt in it
8 Find out if salt and sugar have the same chemicals in them
6 Grind up some saltwater taffy to see if you can get salt, sugar, and water
26 Try to mix salt, sugar, and water. Let them stand, and see what happens
6 I don't know

☐ M=62 (68)
☐ F=10
☒ VS
☐ *

53. Scientists would have the most trouble testing which of the following?

- 16 I have a fever
8 I am 2.1 metres tall
7 My dog weighs 5 kilograms
11 I can lift a 10 kilogram box
47 My dog is better than your dog
12 I don't know

☐ M=48 (49)
☐ F=45
☒ S
☐ *

54.



You hold a paper with the word POPSICLE facing the mirror, as shown in this picture. What does the word look like when you look into the mirror?

- 24 POPSICLE
10 POPSICLE
44 POPSICLE
21 ELCISPOB
1 I don't know

☐ M=92 (70)
☐ F=46
☒ VS
☐ *

23

Here are two pictures of a pot of water on a stove. Picture 2 was taken 5 minutes after picture 1.



PICTURE 1



PICTURE 2

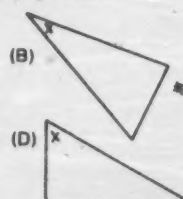
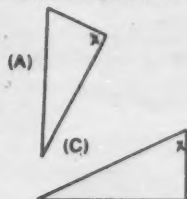
55. Which choice is the best way of telling that there has been a CHANGE?

- 19 The water is boiling in picture 2 ☐ 1 (71)
 8 The gas is on in picture 2 ☐ 2 M=57
 8 The water gets hot when the gas is on ☐ 3 F=61
 3 The water is not boiling in picture 1 ☐ 4 S
 59 The water is boiling in picture 2, but it is not boiling in picture 1 ☐ 5
 2 I don't know ☐ 6

Look at the picture.



56. It is a picture that Mary drew of a dog in a yard. Which of the following pictures shows an X in the same place in the yard as the dog in Mary's picture?



- 3 A ☐ 1 (72)
 90 B ☐ 2 M=90
 1 C ☐ 3 F=90
 4 D ☐ 4 S
 1 I don't know ☐ 5

24

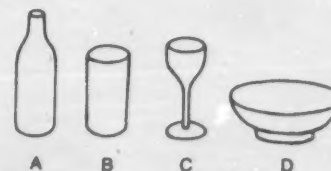
57. If your teacher gave you a white powder and told you to try to find out what it is, which of the following must you NEVER do (unless told to by the teacher)?

- 4 Put water on it ☐ 1 (73)
 8 Put iodine solution on it ☐ 2 M=79
 79 Taste it ☐ 3 F=60
 7 Study it under a microscope ☐ 4 S
 2 I don't know ☐ 5

58. Mary and Dave each bought the same kind of rubber ball. Mary said, "My ball bounces better than yours." Dave replied, "I'd like to see you prove that." What should Mary do?

- 67 Drop both balls from the same height and see which bounces higher ☐ 1 (74)
 3 Throw both balls against a wall and see how far each ball bounces off the wall ☐ 2 M=71
 3 Drop the two balls from different heights and see which bounces higher ☐ 3 F=62
 15 Throw the balls down against the floor and see how high they bounce ☐ 4 VS
 10 Feel the balls by hand to find which is harder ☐ 5
 1 I don't know ☐ 6

59. Which one of these shown below is the best container to measure the amount of rainfall in millimetres?



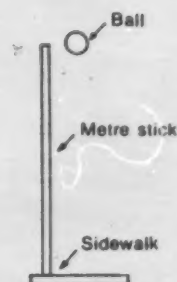
- 21 A ☐ 1 (75)
 40 B ☐ 2 M=43
 4 C ☐ 3 F=37
 32 D ☐ 4 S
 3 I don't know ☐ 5

25

60. How do we get scientific laws such as the law of gravity?

- ☐ 5 Scientists vote on them
☐ 4 They are made by the police
☐ 14 They are passed by the government
☒ 64 They come from many experiments
☐ 8 I don't know

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9
☐ 10
☐ 11
☐ 12
☐ 13
☐ 14
☐ 15
☐ 16
☐ 17
☐ 18
☐ 19
☐ 20
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☐ 88
☐ 89
☐ 90
☐ 91
☐ 92
☐ 93
☐ 94
☐ 95
☐ 96
☐ 97
☐ 98
☐ 99
☐ 100



Look at the pictures of imaginary pond water animals.

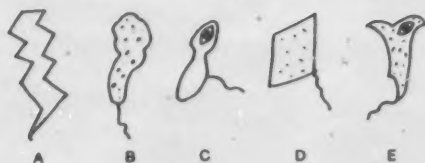
Plugs look like all those in row 1.



But NONE of those in row 2 is a Plug.

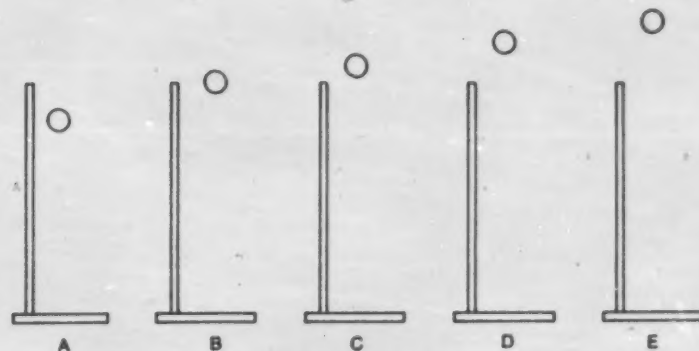


61. Which one in row 3 is a Plug?



- ☐ 8 A
☐ 9 B
☐ 14 C
☐ 3 D
☒ 62 E
☐ 4 I don't know

A ball is dropped on the sidewalk from a height of one metre as the picture above shows.



62. Which of the above pictures shows how high the ball could bounce?

- ☐ 20 Picture A
☐ 17 B
☐ 5 C
☐ 3 D
☐ 51 E
☐ 4 I don't know

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9
☐ 10
☐ 11
☐ 12
☐ 13
☐ 14
☐ 15
☐ 16
☐ 17
☐ 18
☐ 19
☐ 20
☐ 21
☐ 22
☐ 23
☐ 24
☐ 25
☐ 26
☐ 27
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☐ 32
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☐ 81
☐ 82
☐ 83
☐ 84
☐ 85
☐ 86
☐ 87
☐ 88
☐ 89
☐ 90
☐ 91
☐ 92
☐ 93
☐ 94
☐ 95
☐ 96
☐ 97
☐ 98
☐ 99
☐ 100

63. When the temperature outside is 25 °C, how should you dress?



A



B



C

- 18 A
36 B
43 C
3 I don't know

- ☐ 1 (79)
☐ 2 M=45
☐ 3 F=41
☒ 4 (W)

64. After studying jars of pond water at your desk, it is important to

- 1 wash your hands with water.
2 wash your hands and desk top with soap and water.
3 spray the room with vinegar and water.
4 stand under a hot light.
5 I don't know.

- ☐ 1 (80)
☐ 2 M=46
☐ 3 F=72
☒ 4 (C)
☐ 5

65. While Joe was sitting under a tree, he watched a bird getting insects from between the cracks of the bark. Which drawing shows the kind of beak this bird likely had?



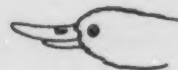
A

☐ 1

(81)



2/ B

☐ 2

I C

☐ 3

*72 D

☐ 4

I I don't know.

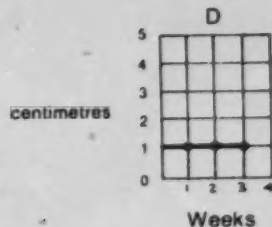
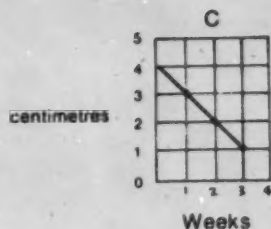
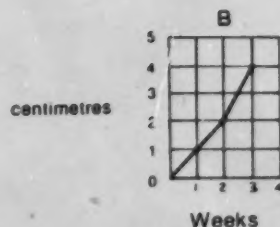
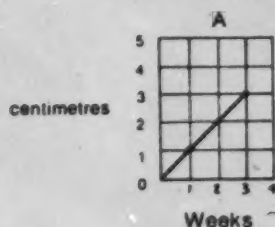
☐ 5

M=75
F=48
(VS)

A plant grows this way

The first week it is 1 centimetre high.
The second week it is 2 centimetres high.
The third week it is 4 centimetres high.

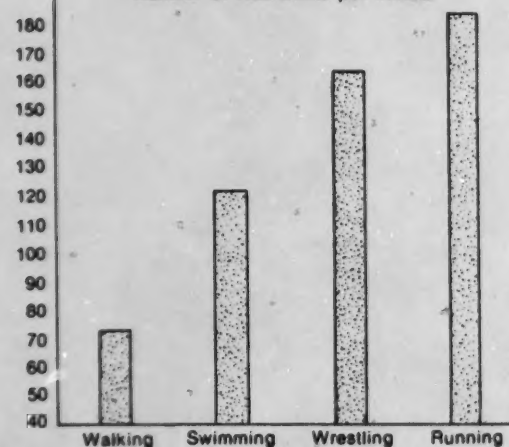
66. Which of the following graphs shows this growth?



1. A
2. B
3. C
4. D
5. I don't know

1. A
2. B
3. C
4. D
5. I don't know

Number of Heartbeats per Minute



67. Look at the graph above. Your heart probably beats fastest when you are

- 1 walking.
2 swimming.
3 wrestling.
4 running.
5 I don't know.

1. ☐
2. ☐
3. ☐
4. ☒
5. ☐

68. When it is raining, which of the following MUST be true?

- 1 It is spring.
2 The Sun is shining.
3 The wind is blowing.
4 There are clouds in the sky.
5 I don't know.

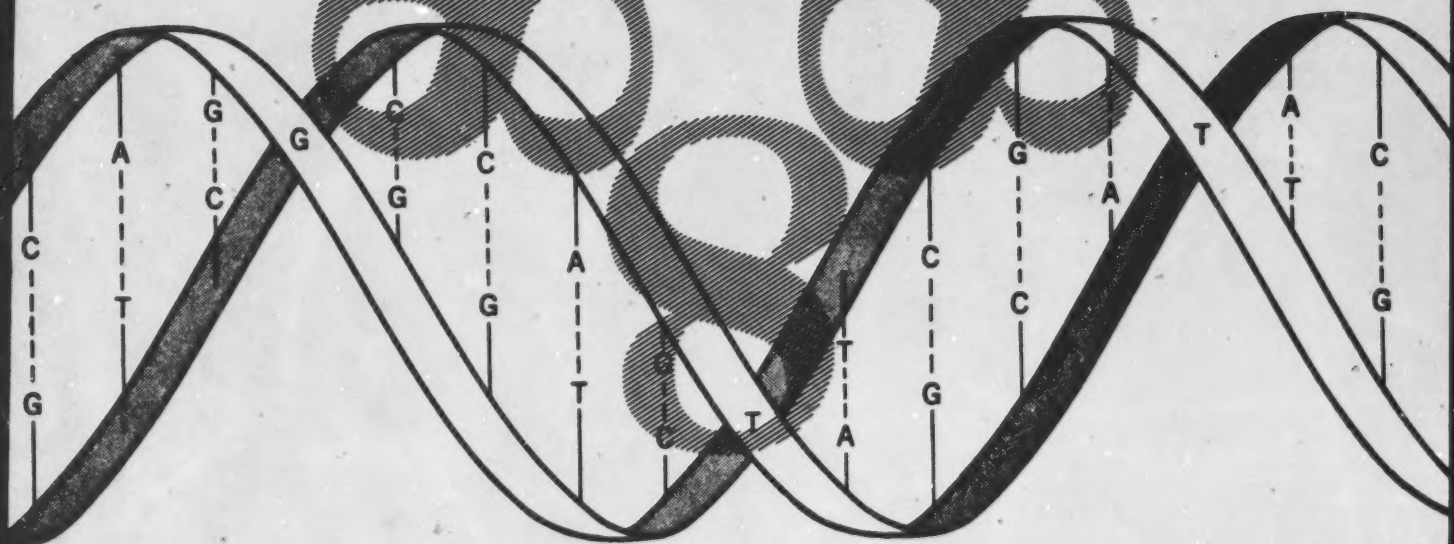
1. ☐
2. ☐
3. ☐
4. ☒
5. ☐

SCIENCE ASSESSMENT

GRADE

Booklet A

8



GRADE 8

Booklet A

**WAIT FOR INSTRUCTIONS
BEFORE STARTING THE TEST**

HOW TO MARK YOUR ANSWER ON THE ANSWER CARD

Use the **SOFT BLACK PENCIL** that is provided to draw a **DARK** horizontal line in the oval which corresponds to the **ONE** best answer for each question.

Do **NOT** use a coloured pencil, ballpoint or other pen. Take care not to let your pencil run beyond the edges of the ovals. If you make a mistake, erase the wrong mark completely.

INSTRUCTIONS

There are several choices available for each question on the test, including "I don't know". Select the **ONE** best answer in each case, and mark it on your card. If you have no idea of the correct response, mark the oval corresponding to "I don't know".

Example: How many months are there in a year?

- A) 10
- B) 12
- C) 24
- D) 52

E) I don't know.

Your answer should be response B, as shown



IF YOU MAKE A MISTAKE, ERASE THE WRONG MARK COMPLETELY

- 3 -

**ON YOUR CARD, FIND THE AREA INDICATED FOR
BACKGROUND INFORMATION**

1. What is your date of birth?

- Year:** A) 1961 or earlier
B) 1962
C) 1963
D) 1964
E) 1965
F) 1966
G) 1967 or later

- Month:** A) January
B) February
C) March
D) April
E) May
F) June
G) July
H) August
I) September
J) October
K) November
L) December

2. Sex:

- A) Male
B) Female

3. Are you now taking Science 8?

- A) Yes
B) No

4. Is Science 8 given on a semester or quarter system in your school?

- A) Semester system
B) Quarter system
C) Neither of the above

5. In what semester/quarter do you take Science 8 this year?

- A) First
B) Second
C) Other
D) Does not apply

6. How many minutes per week, on the average, do you or did you spend on science homework this year?

- A) None at all
B) Less than 30 minutes per week
C) 30 to 60 minutes per week
D) 60 to 90 minutes per week
E) More than 90 minutes per week

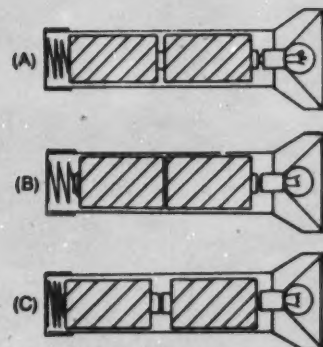
7. Write the Code Number for your school in the space provided on your answer card.

DO NOT TURN THE PAGE UNTIL YOUR TEACHER TELLS YOU.

Look at the diagrams below.

1. To make the flashlight work, which way must we place the batteries?

- 32 A) $M = 91$
 8 B) $F = 73$
 5 C) VS
 1 D) I don't know.

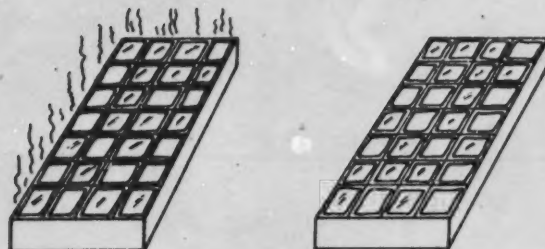


2. Doug was trying to take the metal screw-top off a jar of jam but it wouldn't turn. What should he do in order to open the jar with the least risk of breaking it?

- 1 A) Force the cap off with a screw driver. $M = 79$
 8 B) Run hot water on the glass part of the jar. $F = 83$
 4 C) Run cold water on the cap. VS
 2 D) Hammer the cap off.
 31 E) Run hot water on the cap.
 3 F) I don't know.

3. Night and day result from the

- 36 A) earth revolving about the sun. $M = 52$
 43 B) spinning of the earth. $F = 34$
 4 C) moon going around the earth. M
 14 D) sun revolving around the earth.
 2 E) I don't know.



4. Above is a picture of two ice cube trays. One is filled with very hot water and one with cold water. Many people say, "Hot water makes ice cubes quicker than cold water". Which choice would be the best statement for helping you plan an experiment to test this?

- 35 A) The hotter the water you start with, the faster it will freeze into ice cubes. $M=34$
 14 B) Hot water freezes into ice cubes fast. $F=35$
 14 C) Hot water freezes at higher temperatures than cold water.
 6 D) Hot water freezes into ice cubes faster because it turns on the refrigerator. (S)
 7 E) Hot water makes a steam which keeps the refrigerator going.
 14 F) I don't know.

5. If you wanted to test the statement you chose in question 4, which factor listed below is the only one you should allow to change during the experiment?

- 56 A) The temperature of the water you use $M=54$
 14 B) The amount of water in each tray $F=57$
 12 C) The position of the trays in the freezer (S)
 6 D) The refrigerator in which you put the trays
 4 E) The kind of trays you use
 7 F) I don't know.

6. Some things that can change during your experiment in the previous question are listed below. Which one changes because of all the others?

- 2 A) The kind of trays you use $M=36$
 5 B) The refrigerator in which you put the trays $F=38$
 37 C) The time it takes for freezing (S)
 31 D) The temperature of the water you use
 16 E) The amount of water in each tray
 8 F) I don't know.

7. Scientists would have the most trouble testing which of the following?

- 6 A) I have a fever. $M=79$
 3 B) I am 2.1 metres tall. $F=78$
 2 C) My dog weighs 5 kilograms. (VS)
 5 D) I can lift a 10 kilogram box.
 74 E) My dog is better than your dog.
 5 F) I don't know.

8. A refrigerator keeps its contents cool by

- 13 A) freshening food. $M=28$
 26 B) transferring heat. $F=23$
 5 C) destroying energy. (M)
 15 D) keeping ice from melting.
 16 E) producing electric charges.
 15 F) I don't know.

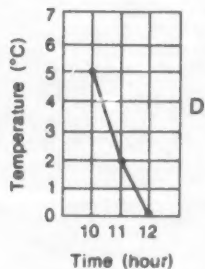
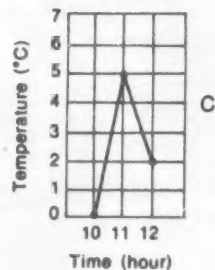
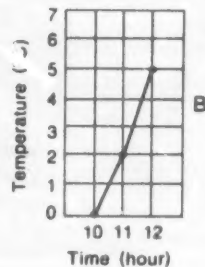
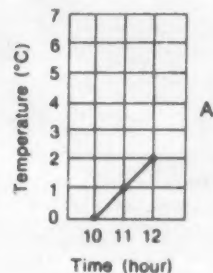
9. If your teacher gave you a white powder and told you to try to find out what it is, which of the following must you NEVER do (unless told to by the teacher)?

- 1 A) Put water on it. $M=91$
 3 B) Put iodine solution on it. $F=93$
 91 C) Taste the material. (VS)
 2 D) Study it under a microscope.
 1 E) I don't know.

10. Sources of energy include which of the following?

1. Natural gas
 2. A charged automobile battery
 3. Water behind a dam
 14 A) 1 only $M=38$
 9 B) 2 only $F=29$
 9 C) 3 only (M)
 21 D) 1 and 3 only
 34 E) 1, 2 and 3
 7 F) I don't know.

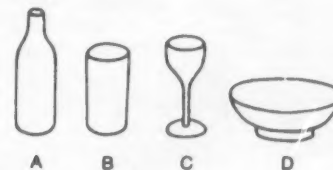
Some children found that the temperature was 0°C at 10 o'clock, 2°C at 11 o'clock, and 5°C at 12 o'clock.



11. Which is the best record of their findings?

- 6 A) $M = 7.1$
 73 B) $F = 72$
 10 C) (VS)
 6 D)
 5 E) I don't know.

Which one of those shown below is the best container to use to measure the amount of rainfall in millimetres?



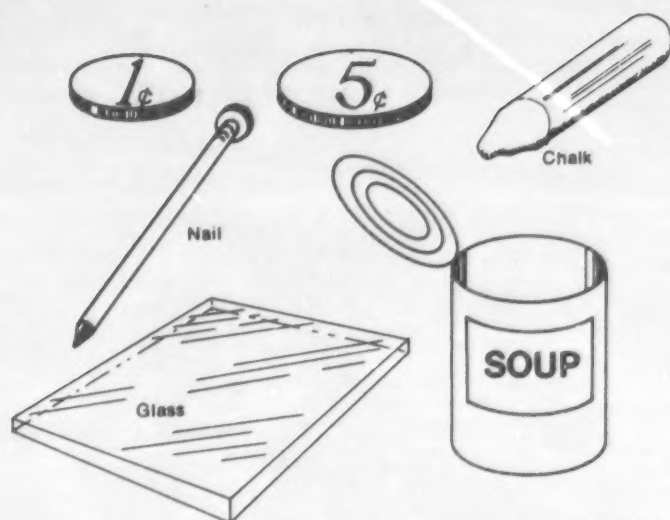
12. 9 A) $M = 68$
 49 B) $F = 68$
 4 C) (S)
 15 D)
 3 E) I don't know.

13. Four of the following are statements of fact. Which statement is a hypothesis?

- 9 A) The boiling point of water is 100°C. $M = 34$
 11 B) A litre of water weighs about 1 kg. $F = 28$
 10 C) Hydrogen was first prepared by Cavendish in 1766. (M)
 11 D) Mt. Robson is not the tallest mountain in B.C.
 31 E) The rings of Saturn were formed from a moon that exploded.
 22 F) I don't know.

14. Fanning can make a campfire burn better because the fanning

- 3 A) raises the atmospheric pressure. $M = 86$
 2 B) warms materials to their kindling points. $F = 78$
 3 C) increases the supply of material that can burn. (VS)
 12 D) increases the supply of oxygen for the burning.
 7 E) provides the energy needed to keep the fire going.
 2 F) I don't know.



15. If a scientist wanted to arrange the above things from hardest to softest, the scientist should

- 34 A) try to scratch each item with each other item. $M = 37$
 18 B) try to see which one bends the most easily. $F = 32$
 19 C) try to see which one breaks the most easily. (M)
 21 D) study them under a microscope.
 7 E) I don't know.

16. The caterpillar is an early stage in the life history of a

- 1 A) fly. $M = 91$
 1 B) bee. $F = 93$
 3 C) grasshopper. (SY)
 42 D) butterfly.
 1 E) mosquito.
 2 F) I don't know.

17. Which of the following is an example of a chemical change?

- 19 A) Melting wax. $M = 29$
 17 B) Burning wood. $F = 25$
 5 C) Crushing stone (W)
 43 D) Freezing water
 5 E) I don't know.

18. This picture shows a marble and a ruler. If the marble rolls from X to Y in 2 seconds at a steady speed, how fast is it going?

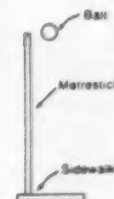
- 12 A) 12 cm per 2 seconds $M = 73$
 9 B) 24 cm per second $F = 64$
 3 C) 24 mm per second (S)
 2 D) 240 mL per second
 64 E) 12 cm per second
 5 F) I don't know.



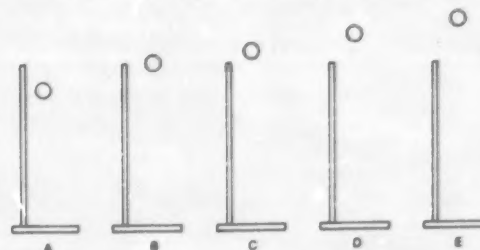
19. A student is required to determine the thickness in centimetres of one razor blade. If he finds that a stack of exactly 200 similar blades measures 2.5 cm, he should report that the thickness of one blade is

- 9 A) 0.0050 cm. $M = 23$
 22 B) 0.0125 cm. $F = 22$
 30 C) 0.025 cm. (W)
 6 D) 0.050 cm.
 1 E) 0.080 cm.
 19 F) I don't know.

- A ball is dropped on the sidewalk from a height of one metre as the picture shows.

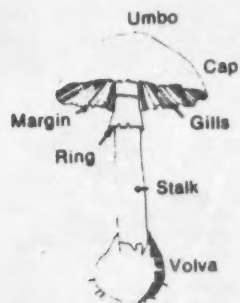


20. Which of the following pictures shows how high the ball could bounce?



- 44 A) $M = 53$
 18 B) $F = 35$
 5 C) (M)
 3 D)
 20 E)
 8 F) I don't know.

Look at the diagram below.



Now look at these diagrams.



21. Two of these mushrooms do not have volvas but do have rings. These mushrooms are

- 8 A) mushroom 1 and mushroom 2. $M = 43$
 50 B) mushroom 2 and mushroom 3. $F = 58$
 21 C) mushroom 1 and mushroom 3. (S)
 9 D) mushroom 4 and mushroom 5.
 3 E) mushroom 1 and mushroom 5.
 6 F) I don't know.

22. Look at the mushrooms again. Two mushrooms that don't have rings are

- 2 A) mushroom 1 and mushroom 2. $M = 52$
 4 B) mushroom 3 and mushroom 4. $F = 55$
 5 C) mushroom 2 and mushroom 5. (VS)
 5 D) mushroom 2 and mushroom 3.
 13 E) mushroom 4 and mushroom 5.
 2 F) I don't know.

23. Look at the mushrooms again. Just from what you can see in the diagram, what do all five have in common?

- 8 A) Caps, gills, and stalks. $M = 87$
 2 B) Volvas. $F = 91$
 1 C) Volvas and rings. (ST)
 2 D) None are poisonous.
 2 E) Rings, caps, volvas, and umbos.
 3 F) I don't know.

24. A meal consists of milk, bread and butter, meat, and cake. To satisfy the rules of good nutrition, what should be added to this meal?

- 2 A) A green or yellow vegetable. $M = 82$
 2 B) Baked beans. $F = 91$
 5 C) Cheese. (VS)
 2 D) Coffee or tea.
 2 E) Pickles and olives.
 2 F) I don't know.

25. A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that

- 4 A) fish once lived on the mountain. $M = 30$
 10 B) the relative humidity was once very high. $F = 20$
 25 C) the mountain was raised up after the fish died. (W)
 8 D) fish used to be amphibians like toads and frogs.
 45 E) the fossil fish was probably carried to the mountain by a great flood.
 5 F) I don't know.

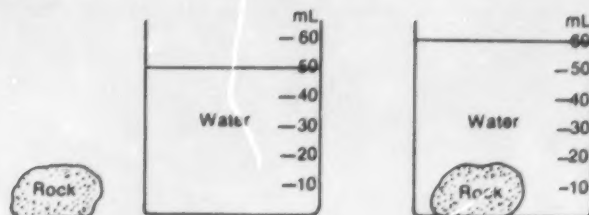
26. Which number is unlucky?

- 1 A) 3. $M = 51$
 2 B) 7. $F = 51$
 3 C) 11. (V)
 4 D) 13.
 5 E) There are no unlucky numbers.
 2 F) I don't know.

27. An average serving of which of the following foods would provide the most protein for building and repairing body tissues?

- 6 A) Boiled potatoes $M = 40$
 22 B) Green beans $F = 41$
 41 C) Lean meat (W)
 11 D) Oatmeal
 5 E) White bread
 13 F) I don't know

A tiny rock is put into a measuring cup that has some water in it. Before the rock is put into the cup, the water is at the 50 mL line. After the rock is added, the water rises to the 60 mL line.



28. The space taken up by the rock is

- 12 A) 10 mL $M = 92$
 2 B) 50 mL $F = 93$
 3 C) 80 mL
 1 D) 110 mL (SP)
 2 E) I don't know.

29. A land developer clears the trees from a large area of land. Shortly after, people living in the area are bothered by large numbers of insects. Which is the best explanation?

- 5 A) Insects prefer areas where there are few trees. $M = 49$
 44 B) Nesting birds kept the number of insects down before the area was cleared. $F = 44$
 19 C) Insects breed quickly where the land has been freshly cleared. (S)
 20 D) Without the trees, the temperature in the area increased.
 9 E) I don't know.

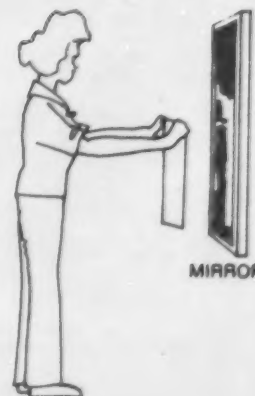
30. As part of an investigation, a cupful of water and a similar cupful of rubbing alcohol were placed on a window sill on a hot sunny day. A few hours later, it was observed that both the cups had less liquid in them and there was less alcohol left than water. The experiment showed that

- 3 A) all liquids evaporate. $M = 75$
 9 B) alcohol gets hotter than water. $F = 75$
 75 C) some liquids evaporate faster than others. (VS)
 3 D) liquids will only evaporate in sunshine.
 2 E) water gets hotter than alcohol.
 2 F) I don't know.

31. Putting sand and salt together makes

- 3 A) a chemical. $M = 59$
 16 B) a compound. $F = 59$
 5 C) an element. (S)
 59 D) a mixture.
 10 E) a solution.
 6 F) I don't know.

You hold a paper with the word POPSICLE in front of you while you look into a mirror as shown in this diagram.



32. What does the word look like when you look into the mirror?

- 16 A) POPSICLE $M = 64$
 4 B) POPSICLE $F = 70$
 67 C) POPSICLE (S)
 11 D) ELCSISPO
 1 E) I don't know.

33. The purpose of a fuse or circuit breaker is to

- 10 A) turn lights on and off.
- 32 B) to protect circuits from carrying too much electricity.
- 11 C) to protect people from getting electric shocks.
- 8 D) to save electricity from being wasted.
- 16 E) to regulate the number of volts in the circuit.
- 12 F) I don't know.

M = 40
F = 23
(M)

34. Some children were trying to find out which of three light bulbs was brightest. The children made several suggestions. Which of these suggestions gives the best start toward finding the answer?

- 6 A) One bulb looks brightest to me so I already know the answer.
- 5 B) All the bulbs look bright to me so there can't be an answer.
- 61 C) It would help if we had a way to measure the brightness of a light bulb.
- 13 D) Let's take a vote; each person will vote for the bulb he thinks is the brightest.
- 6 E) I don't know.

M = 47
F = 72
(S)

35. This is a drawing of a barometer. From reading it, which of the following statements about the weather can you make?



- 1 A) The barometric pressure is rising.
- 60 B) You do not have enough information to tell what will happen.
- 11 C) The weather is changing.
- 2 D) It will rain in two days.
- 7 E) The barometric pressure is falling.
- 10 F) I don't know.

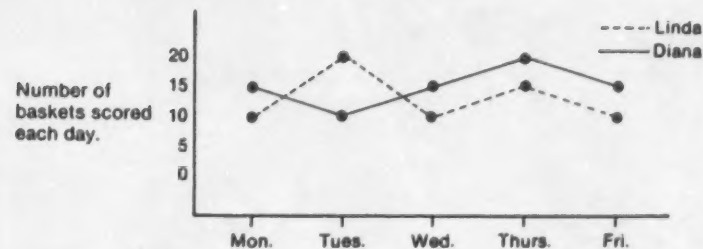
M = 61
F = 60
(S)

36. In terms of the theory of natural selection, why do giraffes have such long necks?

- 8 A) Stretching to get food in high trees has made their necks longer.
- 4 B) There is something inside of giraffes which keeps making longer necks.
- 7 C) Giraffe food contained vitamins which caused the vertebrae to lengthen.
- 24 D) Giraffe necks have gotten longer and longer as time has gone on, but nobody has any idea why this is.
- 41 E) Giraffes born with the longest necks have been able to stay alive when food was scarce and have passed this trait on to their offspring.
- 14 F) I don't know.

M = 40
F = 42
(M)

In basketball practice, Linda and Diana shot 20 shots every day for five days. The graph shows the number of baskets scored each day.



37. Look at the graph. Which of the following statements is correct?

- 67 A) Diana scored more baskets than Linda on Monday and Friday.
- 9 B) Linda scored fewer baskets than Diana on two days only.
- 6 C) Diana and Linda scored the same number of baskets on Tuesday.
- 6 D) Linda scored more baskets than Diana on Friday.
- 8 E) I don't know.

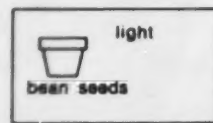
M = 67
F = 67
(S)

38. Seeds come from which of the following parts of a plant?

- 1 A) Bark
- 71 B) Flower
- 7 C) Leaf
- 11 D) Root
- 5 E) Stem
- 3 F) I don't know.

M = 70
F = 73
(S)

Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and a pot with 6 bean seeds on the window sill.



38. He added the same amount of water to both pots. The bean seeds grow better than the radish seeds, so Tom said his plants grow best in the light. To be able to say this, he should have

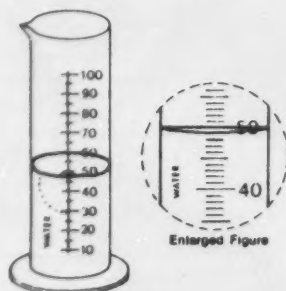
- 3 A) watered both pots more. $M = 77$
 5 B) watered the radish seeds more. $F = 81$
 7 C) put the same kind of seeds in both pots. (VS)
 4 D) grown the seeds in water instead of soil. (VS)
 6 E) I don't know.

40. When we say that a scientist has formed a HYPOTHESIS about an experiment, we mean that he has

- 7 A) indicated which measurements were made. $M = 50$
 6 B) designed equipment needed for the experiment. $F = 49$
 18 C) described how the experiment turned out. (M)
 41 D) made a careful guess about what will happen.
 18 E) I don't know.

41. The 100 mL measuring cylinder contains a certain volume of water. The enlarged figure shows a view of the surface of the water as seen from the side. What is the volume of the water?

- 27 A) 50 mL $M = 60$
 39 B) 49 mL $F = 58$
 6 C) 48 mL (S)
 2 D) 47 mL
 1 E) 46 mL
 3 F) I don't know.



42. The only star you usually see in the daytime is

- 4 A) Venus. $M = 71$
 73 B) the Sun. $F = 73$
 8 C) the Moon. (VS)
 3 D) the Polestar.
 2 E) Alpha Centauri.
 7 F) I don't know.

43. Under which of the following conditions does water evaporate fastest?

- 8 A) On a hot and dry day $M = 84$
 8 B) On a hot and moist day $F = 83$
 2 C) On a cold and dry day (VS)
 2 D) On a cold and moist day
 2 E) On a calm and moist day
 2 F) I don't know.

Here are two pictures of a pot of water on a stove. Picture 2 was taken 5 minutes after picture 1.



Picture 1



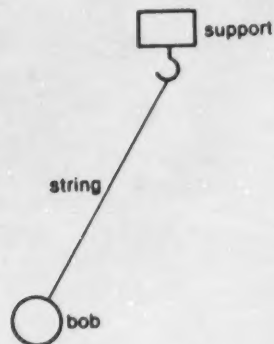
Picture 2

44. Which choice is the BEST way of telling that there has been a CHANGE?

- 12 A) The water is boiling in picture 2. $M = 56$
 8 B) The gas is on in picture 2. $F = 59$
 15 C) The water gets hot when the gas is on. (S)
 3 D) The water is not boiling in picture 1.
 17 E) The water is boiling in picture 2, but it is not boiling in picture 1.
 2 F) I don't know.

45. If acid is spilled on your skin, what should be done immediately?

- 3 A) Pour alkali on the affected part. $M = 75$
 77 B) Wash the affected part with water. $F = 76$
 5 C) Cover the affected part with a dry sponge.
 8 D) Apply antiseptic cream to the affected part. (VS)
 6 E) I don't know.



46. The length of time required for a pendulum bob, like that shown above, to make one complete swing depends mostly upon

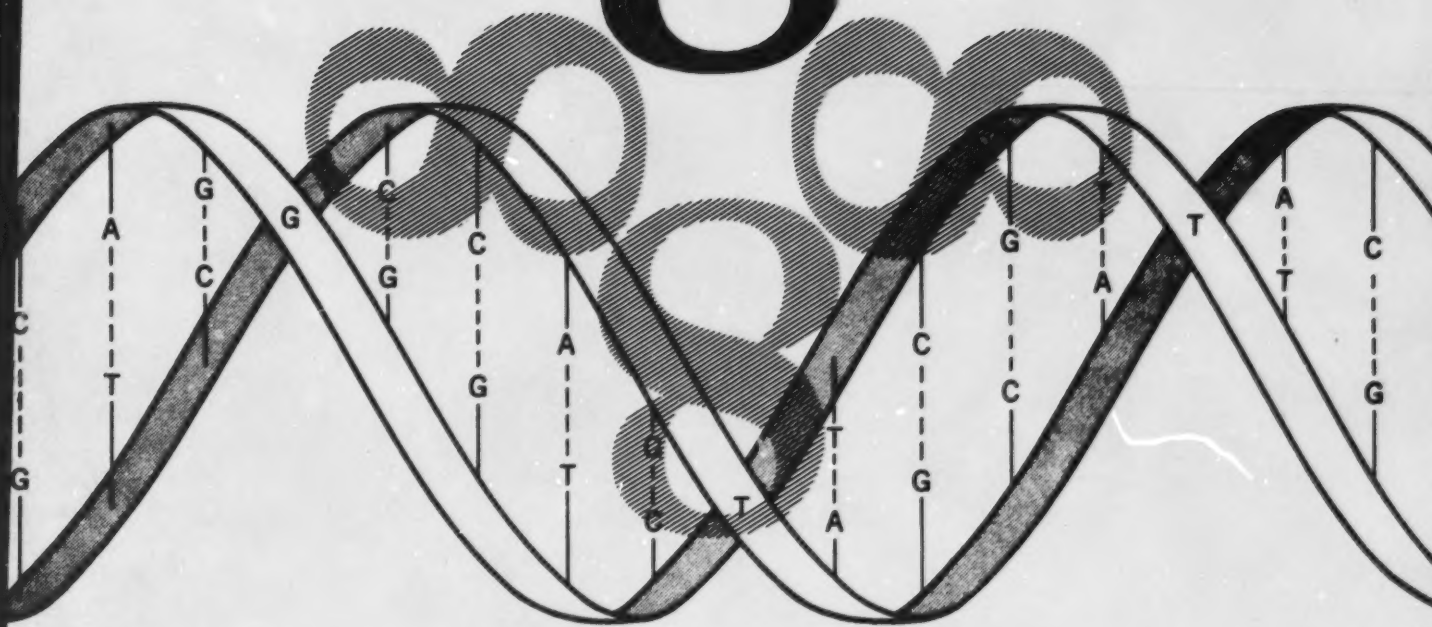
- 25 A) where the bob is released. $M = 47$
 17 B) the mass of the bob. $F = 44$
 4 C) the temperature of the air.
 46 D) the length of the pendulum string. (S)
 7 E) I don't know.

SCIENCE ASSESSMENT

GRADE

Booklet B

8



GRADE 8

Booklet B

WAIT FOR INSTRUCTIONS
BEFORE STARTING THE TEST

HOW TO MARK YOUR ANSWER ON THE ANSWER CARD

Use the SOFT BLACK PENCIL THAT IS PROVIDED to draw a DARK horizontal line in the oval which corresponds to the ONE best answer for each question.

Do NOT use a coloured pencil, ballpoint or other pen. Take care not to let your pencil run beyond the edges of the ovals. If you make a mistake, erase the wrong mark completely.

INSTRUCTIONS

There are several choices available for each question on the test, including "I don't know". Select the ONE best answer in each case, and mark it on your card. If you have no idea of the correct response, mark the oval corresponding to "I don't know".

Example: How many months are there in a year?

- A) 10
- B) 12
- C) 24
- D) 52

E) I don't know.

Your answer should be response B, as shown

☐ A

☒ B

☐ C

☐ D

☐ E

IF YOU MAKE A MISTAKE, ERASE THE WRONG MARK COMPLETELY.

ON YOUR CARD, FIND THE AREA INDICATED FOR

BACKGROUND INFORMATION

1. What is your date of birth?
 Year: A) 1961 or earlier
 B) 1962
 C) 1963
 D) 1964
 E) 1965
 F) 1966
 G) 1967 or later

 Month: A) January
 B) February
 C) March
 D) April
 E) May
 F) June
 G) July
 H) August
 I) September
 J) October
 K) November
 L) December
2. Sex:
 A) Male
 B) Female
3. Are you now taking Science 8?
 A) Yes
 B) No
4. Is Science 8 given on a semester or quarter system in your school?
 A) Semester system
 B) Quarter system
 C) Neither of the above
5. In what semester/quarter do you take Science 8 this year?
 A) First
 B) Second
 C) Other
 D) Does not apply
6. How many minutes per week, on the average, do you or did you spend on science homework this year?
 A) None at all
 B) Less than 30 minutes per week
 C) 30 to 60 minutes per week
 D) 60 to 90 minutes per week
 E) More than 90 minutes per week
7. Write the Code Number for your school in the space provided on your answer card.

DO NOT TURN THE PAGE UNTIL YOUR TEACHER TELLS YOU.

A doctor kept records of breathing rates of people when they were resting. He made the chart below.

BREATHING RATES	
Persons	Breaths in a minute
Baby boys	38
7-yr-old girls	25
7-yr-old boys	25
10-yr-old boys	20
Mothers	18

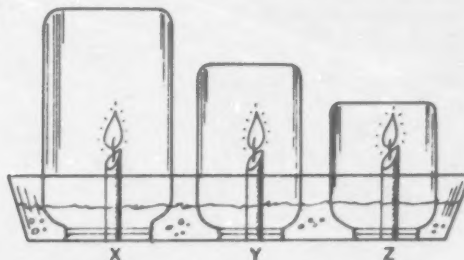
1. The chart suggests that

- 7 A) boys breathe faster than girls. $M = 83$
 1 B) girls breathe faster than boys. $F = 86$
 3 C) older people breathe faster than younger people. (S)
 6 D) younger people breathe faster than older people.
 2 E) I don't know.

2. Which of the following helps to account for the fact that a compass can be used to find north on Earth?

- 7 A) Earth has only one moon. $M = 75$
 65 B) Earth has a magnetic field. $F = 56$
 8 C) Earth reflects the Sun's light. (S)
 3 E) Earth's temperature is not constant.
 11 F) I don't know.

3. If three jars were placed over three candles at the same time, what would happen?



- 11 A) All the candles would go out right away. $M = 73$
 7 B) The candles would go out in this order — X, Y, Z. $F = 61$
 67 C) The candles would go out in this order — Z, Y, X. (S)
 13 D) The candles would all burn for awhile and then would go out together.
 2 E) I don't know.

7.

4. Which of the following is NOT a cause of winds?

- A) Differences in air pressure
 B) Differences in air temperature between different latitudes
 C) Differences in elevation on the earth's surface
 D) Differences in air temperature over the sea and over dry land
 E) Lines of force in the earth's magnetic field

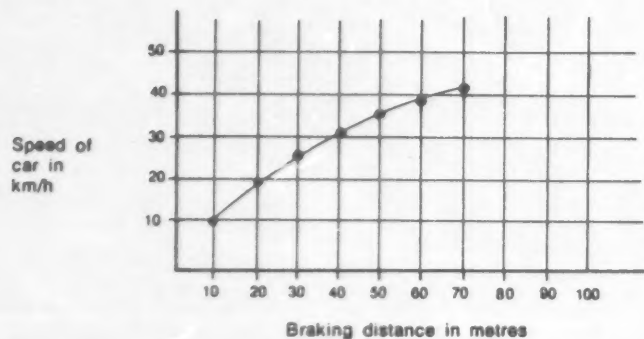
F) I don't know.

M = 47

F = 41

(M)

This graph shows how many metres it takes a car to stop after braking (braking distance), when the car is travelling at different speeds.



5. Look at the graph. Predict the braking distance at 15 km/h.

7. A) 10 metres
 66. B) 15 metres
 9. C) 5 metres
 10. D) 20 metres

M = 71

F = 60

(S)

9. E) I don't know.

6. Look at the graph again. Predict the braking distance at 44 km/h.

20. A) 70 metres
 43. B) 75 metres
 5. C) 100 metres
 17. D) 80 metres

M = 48

F = 37

(S)

14. E) I don't know.

7. John's pet rabbit was injured by a car and became lame. Some months after the accident she produced a litter. Which of the following describes what the babies would probably be like?

5. A) All of them would be lame because the mother was lame.
 10. B) Most of them would be lame but not all of them because the father was not lame.
 6. C) Most of them would not be lame because the father was not lame.
 68. D) None of them would be lame because the mother's lameness was due to an accident.

5. E) Only one of them would be lame because the mother was lame.

6. F) I don't know.

M = 64

F = 72

(VS)

8. About what topic do scientists know everything?

7. A) Clouds
 13. B) Stars
 11. C) Trees
 63. D) No topic

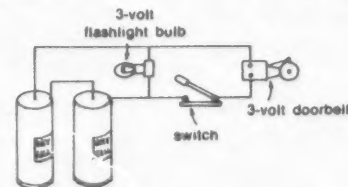
M = 61

F = 64

(W)

5. E) I don't know.

9. In the diagram below, the dry cells are new and are in good working order.



What occurs when the switch is NOT closed?

22. A) The bulb is lighted, but the bell does not ring.
 20. B) Neither the bulb nor the bell operates.
 25. C) The bulb is lighted and the bell rings.
 3. D) The bell rings, but the bulb is not lighted.
 18. E) No current flows from the dry cells.

M = 34

F = 11

(M)

11. F) I don't know.

10. A litre of water at a temperature of 50°C is mixed with a litre of water at 70°C. The temperature of the water just after mixing will be ABOUT

7. A) 20°C
 2. B) 50°C
 47. C) 60°C
 8. D) 70°C
 32. E) 120°C

M = 54

F = 40

(W)

4. F) I don't know.

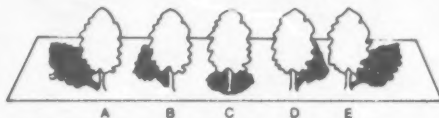
11. You go to the store to buy enough clothesline to stretch from one end of the garden to the other. The problem is, you don't have a ruler to measure the garden. Luckily you find a 'stick' which you can use to measure the garden. You find that the garden is 10 'sticks' long. When you go to the store, why must you remember to take the stick with you?

- 1 A) So the store can see what your stick is made of. $M = 90$
 1 B) So the store can see the shape of your stick. $F = 92$
 91 C) So the store knows how long your stick is. (ST)
 5 D) All of the above.
 2 E) I don't know.

12. Bubble-Pop and Zing are two brands of orange drink. A test was done by a market researcher on 120 people who said they were regular Zing drinkers. Each person was blindfolded then given a glass of Bubble-Pop and a glass of Zing. They were asked which drink they liked better. A newspaper advertisement later reported that "Just over half of the Zing drinkers who stated a preference chose Bubble-Pop." What does this probably mean?

- 21 A) Bubble-Pop tastes better than Zing. $M = 36$
 27 B) More people like Bubble-Pop than Zing. $F = 35$
 13 C) When blindfolded, people like Bubble-Pop better than Zing. (M)
 55 D) There is little taste difference between Bubble-Pop and Zing.
 2 E) I don't know.

At different times during a sunny day, a tree was seen to have cast a shadow of different lengths as shown in the diagram below.



13. Which diagram shows the shadow at mid-day?

- 3 A) $M = 91$
 2 B) $F = 84$
 88 C) (VS)
 2 D)
 2 E)
 2 F) I don't know.

14. After studying jars of pond water at your desk, it is important to

- 15 A) wash your hands with water. $M = 70$
 71 B) wash your hands and desk top with soap and water. $F = 75$
 2 C) spray the room with vinegar and water. (S)
 1 D) stand under a hot light.
 9 E) I don't know.

10.

15. What is the main way that sweating helps your body?

- 27 A) It helps cool your body. $M = 33$
 11 B) It keeps your skin moist. $F = 25$
 3 C) It keeps you from catching cold.
 49 D) It gets rid of the salt in your body. (W)
 6 E) I don't know.

While Joe was sitting under a tree, he watched a bird getting insects from between the cracks of the bark.

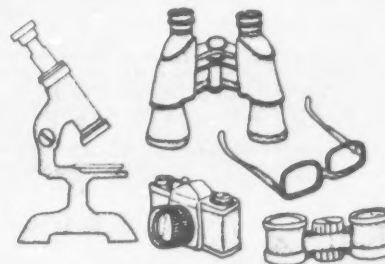


16. Which drawing shows the kind of beak this bird had?

- 7 A) $M = 80$
 13 B) $F = 73$
 1 C) (VS)
 76 D)
 2 E) I don't know.

17. This is a picture of 5 objects that are alike in one special way. How are they alike?

- 0 A) They are all the same shape. $M = 91$
 7 B) They all help you see things that are far away. $F = 84$
 1 C) They are all made of metal. (ST)
 90 D) They all have lenses.
 2 E) They all make things look smaller.
 0 F) I don't know.



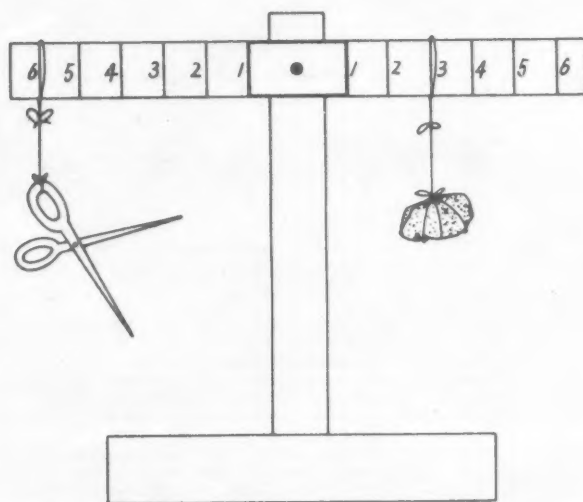
11.

18. Which of the following have probably been on Earth the shortest time?

- 4 A) Alligators
9 B) Dragonflies
3 C) Fish
6 D) Men
6 E) Snails
8 F) I don't know.

M = 73
F = 65
VS

Look at the picture carefully.



19. From the picture you can say that

- 10 A) the scissors and the rock weigh about the same.
33 B) the scissors weigh about two times as much as the rock.
39 C) the rock weighs about two times as much as the scissors.
16 D) the rock weighs about three times as much as the scissors.

M = 46
F = 32
S

2 E) I don't know.

12.

A student did an experiment to see how many pieces of paper could be picked up with a comb that had been run through his hair. He did the same experiment 3 times and here are his results.

Trial	No. of Pieces of Paper Picked Up
1	4
2	6
3	3

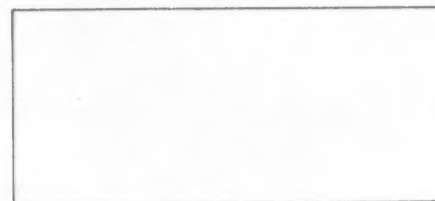
20. These results vary quite a bit. How could he BEST get a more accurate result?

- 8 A) Take one more reading and see to which one of the three it is nearest.
36 B) Take several more readings and average the results.
34 C) Average the three results he has already.
13 D) Repeat the experiment with another comb.

M = 38
F = 33
W

8 E) I don't know.

Use the ruler provided to measure the long side of this rectangle.



21. The length is

- 2 A) 11 centimetres.
90 B) 10 centimetres.
6 C) 9 centimetres.
1 D) 8 centimetres.

M = 92
F = 89
VS

/ E) I don't know.

22. Which of the following products can be made from wood?

- 1 paper
2 disinfectants
3 alcohol

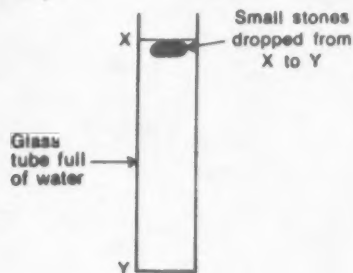
- 80 A) 1 only
10 B) 1 and 3
2 C) 2 only
6 D) 1, 2 and 3

M = 6
F = 5
W

2 E) I don't know.

13.

Six small stones of nearly equal size were dropped through the water in the tube below. The time taken for the stones to fall from X to Y is shown in the table to the right.



Stone	Time (seconds)
1	9
2	11
3	15
4	8
5	10
6	13

23. The mean (average) time for a stone to drop was

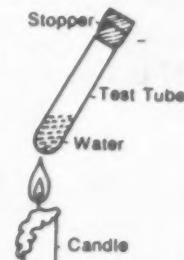
- 7 A) 8 seconds. $M = 64$
 9 B) 7 seconds. $F = 61$
 62 C) 11 seconds. S
 13 D) 12 seconds.
 8 E) I don't know.

24. Which of the following statements is an opinion rather than a fact about cats?

- 8 A) Cats eat mice. $M = 69$
 4 B) Cats have fur. $F = 75$
 2 C) Cats have tails. S
 10 D) Siamese cats are related to tigers.
 72 E) Siamese cats are prettier than other cats.
 3 F) I don't know.

25. Water is heated as shown in the diagram at the right. If the stopper pops out, which of the following is most important in accounting for this?

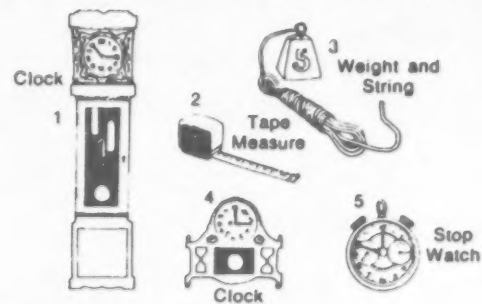
- 18 A) The stopper gets hot and expands. $M = 63$
 55 B) Some of the water is changed to steam. $F = 47$
 9 C) The air in the test tube absorbs heat. S
 1 D) The glass tube gets very hot and starts to melt.
 10 E) The glass test tube expands more than the stopper.
 5 F) I don't know.



26. Each year the Earth moves once around

- 2 A) Mars. $M = 78$
 2 B) Saturn. $F = 72$
 75 C) the Sun. S
 13 D) the Moon.
 4 E) all of the other planets.
 4 F) I don't know.

This is a picture of 5 objects. If you want to study the relationship between the length of a pendulum and how long it takes to complete one swing, which things would be best to use?



27. 17 A) 1 and 4
 40 B) 2, 3, and 5
 9 C) 1, 2, and 4
 9 D) 2 and 3
 13 E) All of the things
 // F) I don't know.

$M = 41$
 $F = 40$
 S

28. Scientific discoveries have come from

- 17 A) almost all countries of the world.
 3 B) only countries with big industries.
 2 C) only countries with large populations.
 3 D) almost all countries in Africa and Asia.
 5 E) I don't know.

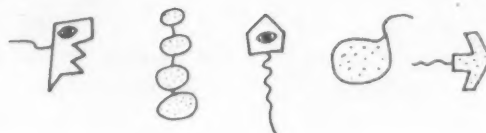
M = 85
 F = 88
 VS

Look at these pictures of imaginary pond water animals.

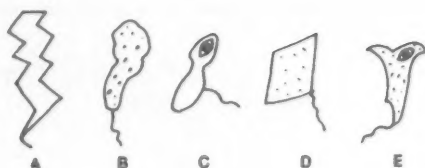
All of these are Plaps:



None of these is a Plap:



29. Which one of these is a Plap?



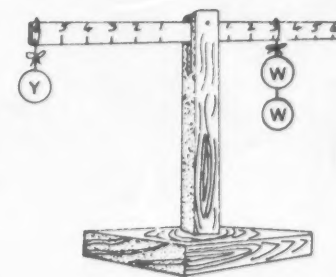
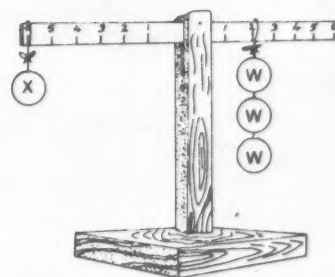
- 2 A)
 9 B)
 8 C)
 2 D)
 67 E)

M = 63
 F = 72
 VS

11 F) I don't know.

16.

Look carefully at the diagrams below in which two objects, X and Y, are balanced with weights. (W)



30. Which of the following statements is correct?

- 30 A) Object X is heavier than object Y.
 13 B) Object Y is heavier than object X.
 41 C) Both objects weigh the same.
 8 D) Object Y is lighter than object X.

M = 44
 F = 39
 S

6 E) I don't know.

31. Green plants are important to animals because the plants

- 16 A) consume both food and oxygen.
 16 B) consume food and give off oxygen.
 7 C) consume food and give off carbon dioxide.
 41 D) produce food and give off oxygen.
 12 E) produce food and give off carbon dioxide.

M = 47
 F = 38
 M

6 F) I don't know.

32. If you were carrying out tests to see which of two new drugs was better for curing a disease, which of the following factors (variables) would be most important to hold constant?

- 2 A) The colour of the drugs
 2 B) The shape of the pills
 13 C) The time of day the drugs were taken
 76 D) The amount of the two drugs taken

M = 74
 F = 78
 VS

6 E) I don't know.

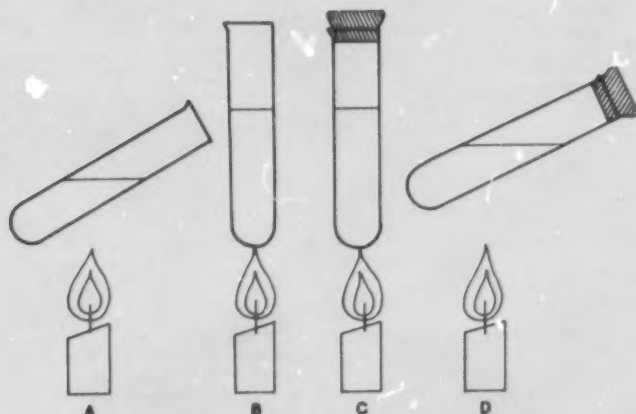
17.

33. If all green plants died, what would be the most important effect on man?

- 13 A) He would have to eat meat only.
 19 B) Sooner or later man would die of starvation.
 31 C) Man would get a little sick because he couldn't get vitamins.
 5 D) Man couldn't build houses because there would be no lumber.
 6 E) The land would be bare and not very pretty for man to look at.
 6 F) I don't know.

M = 41
 F = 34
 (M)

34. Which is the correct method of heating a liquid in a test tube?



- 27 A) M = 30
 32 B) F = 25
 15 C) (W)
 12 D)
 3 E) I don't know.

35. The reason milk kept in a refrigerator does not go sour quickly is that the cold

- 2 A) changes the water of the milk into ice.
 9 B) separates the cream.
 19 C) slows down the action of bacteria.
 2 D) keeps flies away.
 3 E) causes a skin to form on the surface.
 5 F) I don't know.

18.

Some boys made a set of chimes by cutting four pieces of pipe to different lengths from a long metal pipe and hanging them as shown in the picture below.



36. Which of the pipes gave the lowest note when they struck it with a hammer?

- 63 A) Pipe X
 17 B) Pipe Y
 2 C) All gave the same note.
 9 D) You cannot tell without trying.
 7 E) It depends on where you hit it.
 3 F) I don't know.

M = 65
 F = 62
 (S)

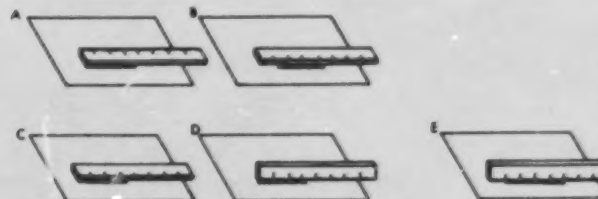
37. How do we get scientific laws such as the law of gravity?

- 2 A) Scientists vote on them.
 2 B) They are made by the police.
 5 C) They are passed by the government.
 15 D) They come from many experiments.
 4 E) I don't know.

M = 83
 F = 83
 (VS)

A student uses a ruler with millimetre markings to measure the length of a line which is drawn on a piece of paper.

To obtain the most accurate measurement, he should use the ruler in which of the following ways?



38. 6 A) M = 19
 8 B) F = 8
 47 C) (W)
 21 D)
 14 E)
 3 F) I don't know.

19.

38. Most of the Earth's surface is

- 5 A) cities and towns.
2 B) farm land.
6 C) solid rock.
14 D) water.

M = 87

F = 82

(VS)

- 2 E) I don't know.

40. Three teaspoons of salt were mixed into a glass of water. The liquid was stirred until it was clear. How could you get back all the salt?

- 8 A) Pour the water through a fine paper filter.
2 B) Use a magnet on the liquid.
53 C) Boil the liquid until all the water is gone.
31 D) Let the liquid stand overnight so that all of the salt goes to the bottom.

M = 59

F = 47

(M)

- 4 E) I don't know.

41. If a student's clothing were to become engulfed in flames while he or she was working in the lab, what would be the best thing for you to do?

- 3 A) Immediately try to find a teacher to whom you could report the accident.
3 B) Throw a beaker of water on the burning person.
53 C) Have the person lie down and smother the fire with a jacket or fire blanket.
7 D) Locate a fire extinguisher and use it to put out the fire.

M = 82

F = 84

(VS)

- 2 E) I don't know.

This is a picture of a boy studying what happens when he tightens or loosens the strings of a guitar.



42. Which one of the following is MOST important to his study?

- 61 A) The lengths and thicknesses of the strings
7 B) The size of the guitar
6 C) The temperature of the strings
10 D) What the guitar and strings are made of
3 E) The age of the guitar

M = 62

F = 62

(VS)

- 9 F) I don't know.

43. Bill always makes good grades in school but is a practical joker. Frank also makes good grades but has no sense of humour. Janet is a serious, intelligent, and popular girl. Who would most likely become a research scientist?

- 13 A) Frank
51 B) Janet
4 C) Either of the boys
17 D) Any of the three

M = 23

F = 32

(W)

- 3 E) I don't know.

44. What is the MOST important thing that the lungs do?

- 1 A) Hold the chest out
3 B) Protect against germs
2 C) Move different parts of the body
14 D) Pump the blood through the body
73 E) Provide a place for oxygen to enter the blood

M = 76

F = 71

(S)

- 3 F) I don't know.

45. When Tom threw his rubber ball into the air, it came back to the ground because

- 9 A) the air pushed it back.
6 B) rubber always bounces back.
50 C) the earth pulled it back.
14 D) the air is very light.
15 E) the earth is a large magnet.

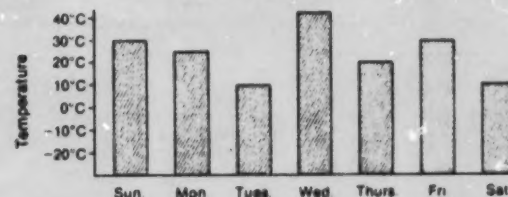
M = 57

F = 44

(M)

- 4 F) I don't know.

The highest temperature recorded each day for a week is shown on the graph below.



46. Which of the following statements is correct?

- 1 A) Monday had the lowest temperature.
2 B) Highest temperature was recorded on Thursday.
3 C) It snowed on Tuesday.
59 D) On Wednesday the temperature was higher than on Sunday.

M = 88

F = 90

(ST)

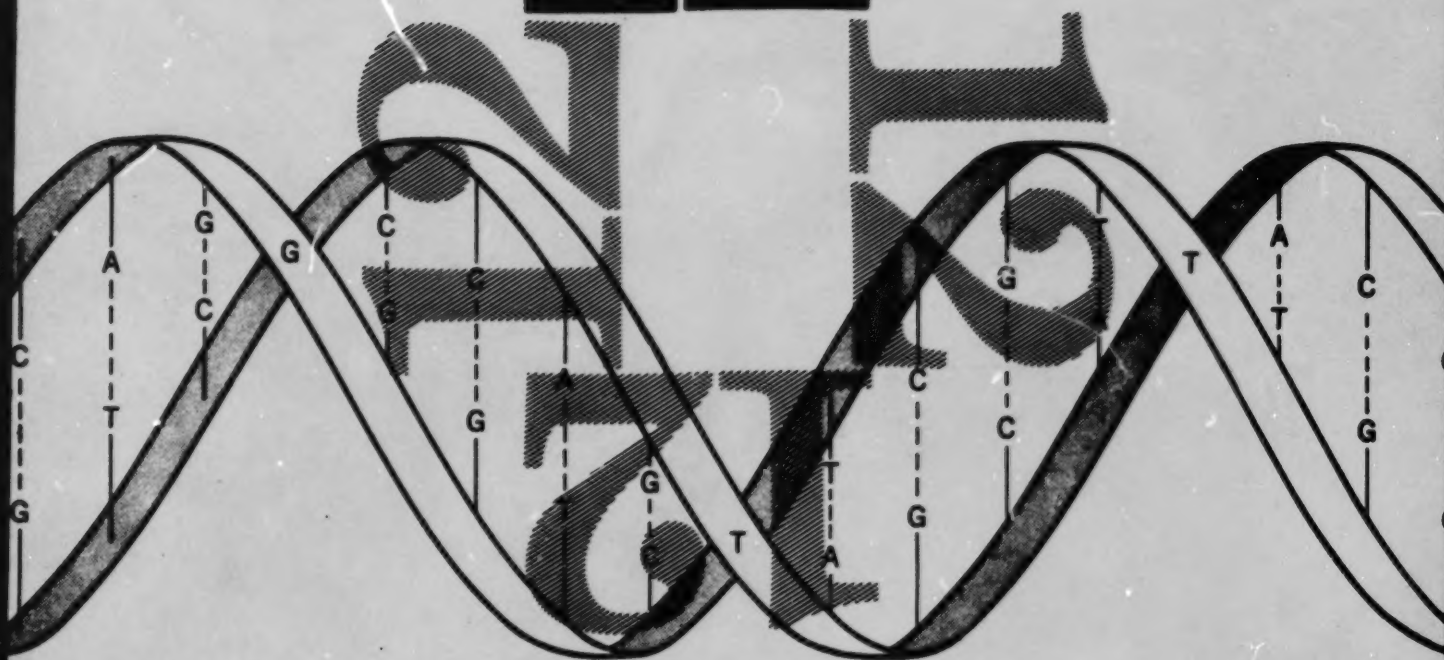
- 4 E) I don't know.

**SCIENCE
ASSESSMENT**

GRADE _____

12

Booklet A



The purpose of this assessment is to find out how well Grade 12 students have learned some of the important skills in Science. The results of the survey will be used by teachers in your district and throughout the province in designing new Science programs. We therefore ask for your co-operation in helping us plan for the future. Depending on your Science background, the questions on this test may be easy or they may be difficult. Regardless of the courses you have taken, it is important that you answer each question as carefully as you can. Thank you for the time and effort you put into this assessment.

INSTRUCTIONS

There are several choices available for each question, including "I don't know". Select the ONE best answer in each case, and mark it on your card. If you have no idea of the correct answer, mark the oval corresponding to "I don't know". Be sure to use the pencil that is provided.

Example: How many months are there in a year?

- A) 10
- B) 52
- C) 12
- D) 24

E) I don't know.

Your answer should be response C, as shown:

☐ A

☐ B

☒ C

☐ D

☐ E

IF YOU MAKE A MISTAKE, ERASE THE WRONG MARK COMPLETELY

BLACKEN THE OVAL ON YOUR ANSWER CARD
THAT CORRESPONDS TO YOUR ANSWER

1. What is your date of birth?

- Year: A) 1957 or earlier
 B) 1958
 C) 1959
 D) 1960
 E) 1961
 F) 1962
 G) 1963 or later

- Month: A) January
 B) February
 C) March
 D) April
 E) May
 F) June
 G) July
 H) August
 I) September
 J) October
 K) November
 L) December

2. Sex:

- A) Male
 B) Female

3. How many minutes per week on the average do you spend on science homework?

- A) I do not take a science course
 B) None at all
 C) Less than 30
 D) 30 to 60 minutes per week
 E) 60 to 90 minutes per week
 F) More than 90 minutes per week

4. Which of the following have you successfully completed? (More than one answer is possible)

- A) Science 8
 B) Science 9
 C) Science 10
 D) Biology 11
 E) Biology 12
 F) Chemistry 11
 G) Chemistry 12
 H) Physics 11
 I) Physics 12
 J) Other Science

5. Which courses are you taking now?

- A) Science 8
 B) Science 9
 C) Science 10
 D) Biology 11
 E) Biology 12
 F) Chemistry 11
 G) Chemistry 12
 H) Physics 11
 I) Physics 12
 J) Other Science

6. If you have a job, how many hours per week do you spend on it?

- A) Less than 5 hours
 B) 5-10 hours
 C) 10-20 hours
 D) More than 20 hours
 E) I do not have a part-time job

7. What is the highest level of education completed by your father or guardian?

- A) Elementary school
 B) Junior secondary school
 C) Senior secondary school
 D) Trade or vocational school
 E) Technical training or some university study
 F) Completed Bachelor's degree
 G) Completed post-graduate degree
 H) I don't know.

8. What is the highest level of education completed by your mother or guardian?

- A) Elementary school
 B) Junior secondary school
 C) Senior secondary school
 D) Trade or vocational school
 E) Technical training or some university study
 F) Completed Bachelor's degree
 G) Completed post-graduate degree
 H) I don't know.

9. What do you plan to do after leaving secondary school?

- A) Look for a job
 B) Business school
 C) Vocational, art or trade training
 D) Technical institute
 E) Community college: university transfer program
 F) Community college: career program
 G) University
 H) Take a year off and then return to an educational program
 I) Take a year off and then look for a job
 J) Other plans
 K) Undecided

10. What is the main reason for your answer to Question 9?

- A) Parents' wishes
 B) Personal ambition
 C) Tired of schooling
 D) Want more education
 E) Best I can hope for
 F) Friends are making the same choice
 G) Strong personal interest
 H) Don't like other choices
 I) Financial reasons
 J) Other reasons

11. What is your father's or guardian's occupation? (Choose the best answer).

- A) Clerical (clerk, secretary, etc.)
 B) Deceased
 C) Farmer (own farm)
 D) Managerial (own business, company manager, executive)
 E) Mining, logging, fishing, farm work
 F) Professional (doctor, lawyer, teacher, graduate engineer)
 G) Retired
 H) Sales (retail business, insurance, real estate)
 I) Semi-skilled work (factory, mill worker)
 J) Service (armed forces, police, motel employee)
 K) Skilled worker (construction, production, tradesman)
 L) Technical (technologist, electronic technician)
 M) Transport, communication (telephone, bus, newspaper)
 N) Unskilled worker (labourer)
 O) Homemaker
 P) Other

12. What is your mother's or guardian's occupation? (Choose the best answer).

- A) Clerical (clerk, secretary, etc.)
 B) Deceased
 C) Farmer (own farm)
 D) Managerial (own business, company manager, executive)
 E) Mining, logging, fishing, farm work
 F) Professional (doctor, lawyer, teacher, graduate engineer)
 G) Retired
 H) Sales (retail business, insurance, real estate)
 I) Semi-skilled work (factory, mill worker)
 J) Service (armed forces, police, motel employee)
 K) Skilled worker (construction, production, tradesman)
 L) Technical (technologist, electronic technician)
 M) Transport, communication (telephone, bus, newspaper)
 N) Unskilled worker (labourer)
 O) Homemaker
 P) Other

13. Write the code number for your school in the space provided on your answer card.

1. A light ray is emitted from the flame of a candle at C and strikes a plane mirror at A.

To an observer at D, the ray will seem to come from



- 26 A) M = 56
53 B) F = 47
9 C) (M)
5 D)
5 E) I don't know.

2. A meal consists of milk, bread and butter, meat, and cake. To satisfy the rules of good nutrition, what should be added to this meal?

- 98 A) A green or yellow vegetable
1 B) Baked beans M = 92
2 C) Cheese F = 96
1 D) Coffee or tea (57)
0 E) Pickles and olives
1 F) I don't know.

3. If a ^{neutral} neutron atom loses an electron, which of the following is formed?

- 5 A) A gas M = 54
50 B) An ion F = 47
2 C) An acid (M)
7 D) A radical
13 E) A molecule
22 F) I don't know.

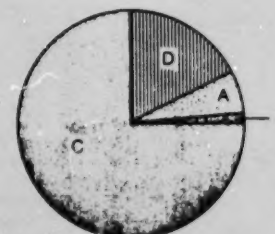
4. Insulating material such as fibreglass, placed in the attics of homes, prevents

- 62 A) escape of warm air from the inside M = 12
21 B) entry of cold air from the outside F = 9
10 C) conduction of heat from the inside (W)
3 D) convection currents in the attic
2 E) I don't know.

5. In the diagram of humid air shown below, oxygen is represented by

- 11 A) M = 32
6 B) F = 22
36 C) (W)
27 D)

- 19 E) I don't know.



Humid Air

6. If a student's clothing were to become engulfed in flames while he or she was working in the lab, what would be the best thing for you to do?

- 1 A) Immediately try to find a teacher to whom you could report the accident. M = 91
1 B) Throw a beaker of water on the burning person. F = 92
12 C) Have the person lie down and smother the fire with a jacket or fire blanket. (VS)
5 D) Locate a fire extinguisher and use it to put out the fire.
1 E) I don't know.

7. Nuclear reactors have been built in some cities and towns as a power source. The energy provided by these reactors as a result of nuclear fission is finally delivered to consumers as

- 2 A) mechanical energy. M = 67
12 B) heat energy. F = 43
6 C) light energy. (M)
8 D) chemical energy.
55 E) electrical energy.
16 F) I don't know.

8. About what topic do scientists know everything?

- 3 A) Clouds M = 84
3 B) Stars F = 13
5 C) Trees (S)
34 D) No topic
5 E) I don't know.

Carefully study the data below.

Following the data you will find a key and, on the opposite page, five statements. You are to assume that the data as presented are true. Evaluate each statement according to the key and mark the appropriate space on your answer card.

DATA:

Analyses were made of the vitamin C content of red, ripe and green tomatoes as soon as they were picked. Mature green tomatoes were stored at the temperatures indicated in the following table. Those which had ripened by the end of the first week were analyzed at the end of the second week, etc. In addition, some mature green tomatoes were analyzed each week.

Condition when taken from field	Temp. when stored	No. of weeks stored	Stage of ripeness when analyzed	Vitamin C mg/100 grams
mature green	not stored	0	mature green	15.0
red ripe	not stored	0	red ripe	16.2
mature green	20°C	1	red ripe	14.4
mature green	20°C	2	red ripe	12.9
mature green	20°C	3	red ripe	8.2
mature green	27°C	1	red ripe	14.0
mature green	27°C	2	red ripe	9.8
mature green	27°C	3	red ripe	7.1
mature green	20°C	1	mature green	10.0
mature green	20°C	2	mature green	7.2

- KEY: A. True. The data alone are sufficient to show that the statement is true.
- B. Probably true. The data indicate that the statement is probably true, that it is logical on the basis of the data but the data are not sufficient to say that it is definitely true.
- C. Insufficient evidence. There are no data to indicate whether there is any degree of truth or falsity in the statement.
- D. Probably false. The data indicate that the statement is probably false, that is, it is not logical on the basis of the data but the data are not sufficient to say that it is definitely false.
- E. False. The data alone are sufficient to show that the statement is false.
- F. I don't know.

9. Tomatoes ripened at 30°C would have less vitamin C after three weeks than those stored at 27°C. A 26 B 36 C 16 D 6 E 7 I Don't Know 7 M = 35 F = 37 (A)
10. Tomatoes could not be stored at 30°C because at this high a temperature they would rot or spoil. A 16 B 19 C 43 D 9 E 7 I Don't Know 6 M = 44 F = 42 (A)
11. The lower the temperature at which tomatoes are stored the less is the breakdown of vitamin C. A 45 B 24 C 7 D 6 E 10 I Don't Know 6 M = 23 F = 24 (C)
12. Heat causes a breakdown of vitamin C molecules. A 36 B 29 C 12 D 6 E 8 I Don't Know 8 M = 30 F = 28 (C)

TURN OVER YOUR ANSWER CARD

13. The green tomatoes which did not ripen in a week had lost about the same amount of vitamin C as those which ripened during the week. A 10 B 8 C 9 D 9 E 45 I Don't Know 12 M = 45 F = 45 (A)
14. The most important function of the white corpuscles of blood is
 9 A) to transport oxygen to the cells of the body.
 53 B) to aid the body in fighting infection.
 9 C) to prevent excessive bleeding from a wound.
 1 D) to dissolve large food molecules.
 5 E) to remove carbon dioxide from the blood.
 M = 55
 F = 61
 12 F) I don't know. (A)
15. Helium, neon, argon, and krypton are in the same family of elements. This means that they
 76 A) have similar chemical properties. M = 79
 1 B) were discovered in the same year. F = 74
 0 C) were discovered by the same person. (V3)
 9 D) can be decomposed into similar substances.
 6 E) have the same melting and boiling points.
 8 F) I don't know.

The next two questions refer to the following information:

A white female mouse was mated with a black male mouse. All of the offspring were spotted; that is, they were white with black spots.

16. The results of this mating indicate that

- 4 A) black is dominant over white.
- 19 B) white is dominant over black.
- 5 C) white is dominant over spotted.
- 1 D) black is dominant over spotted.
- 68 E) neither black nor white is completely dominant.
- 5 F) I don't know.

M = 66
F = 70
(S)

17. If the tails of the white female and the black male parent mice were cut off, and if these mice were then mated,

- 71 A) all of the offspring would be spotted and would have tails.
- 5 B) all of the offspring would be spotted and would have no tails.
- 7 C) some of the offspring would have tails and some would not, but all would be spotted.
- 7 D) some of the offspring would be black with tails, some would be white with tails, and some would be spotted but without tails.
- 9 E) I don't know.

M = 71
F = 70
(S)

18. A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that

- 2 A) fish once lived on the mountain.
- 5 B) the relative humidity was once very high.
- 48 C) the mountain was raised up after the fish died.
- 6 D) fish used to be amphibians like toads and frogs.
- 33 E) the fossil fish was probably carried to the mountain by a great flood.
- 5 F) I don't know.

M = 56
F = 39
(M)

19. Astrologers use the position of the stars and planets at the hour, day, and minute of a person's birth to predict his future. Which one of the following statements regarding this practice would be accepted by scientists?

- 3 A) The modern astrologer can now predict one's future more accurately because better telescopes are in use.
- 68 B) There is no evidence that astrologers can predict the future of an individual on the basis of stars and planets.
- 2 C) Some astrologers inherit the ability to understand the stars from their mothers or their fathers.
- 26 D) Study and long years of training in astrology make an astrologer's predictions of one's future more accurate.
- 1 D E) I don't know.

M = 66
F = 54
(S)

20. Which one of the following statements best describes the connection between science and technology today?

- 51 A) Technology involves the practical applications of scientific knowledge.
- 12 B) Science depends on technology for ideas and the organization of experimental work.
- 5 C) Workers in science use the laws and principles discovered by workers in technology.
- 20 D) Technology is the part of science that deals with mechanical problems.
- 12 E) I don't know.

M = 55
F = 46
(M)

21. Are biology, chemistry, and physics related? They are

- 9 A) not related because they are built on different sets of fundamental principles.
- 58 C) related because the observations, principles, and ideas of each field have connections with the other two.
- 11 C) related because mathematics serves to unify the sciences.
- 15 D) not related because biologists, chemists, and physicists study very different natural phenomena.
- 7 E) I don't know.

M = 57
F = 59
(M)

22. The fact that man's system of capillaries consists of numerous vessels with very small diameters rather than a few larger vessels is advantageous because

- 2 A) a smaller volume of blood comes into contact with the cells.
- 54 B) the blood is distributed more uniformly throughout the tissues.
- 11 C) the heart can pump blood through the body with less effort.
- 6 D) the blood pressure in the arteries is decreased.
- 5 E) the rate of blood flow is increased.
- 21 F) I don't know.

M = 56
F = 50
(M)

23. Which of the following substances must be kept away from sparks or open flames?

- 17 A) Hydrochloric and sulfuric acid
- 13 B) Sodium hydroxide and potassium hydroxide
- 13 C) Alcohol and ether
- 1 D) Tin and lead
- 4 E) I don't know.

M = 72
F = 53
(M)

Read this extract from a pamphlet published by a British Columbia forest company, and answer the four questions that follow.

Research in Pulp and Paper

Paper is made by suspending cellulose fibres in water then draining off the water through a screen so that the fibres form a sheet-like web on the screen surface. On drying, the fibres stick together through a natural attraction known as "hydrogen bonding" which gives strength to the sheet.

Cellulosic fibres, providing the skeletal framework to support plant life, occur widely in nature. The most abundant source lies in wood.

Wood contains, in addition to cellulose fibres, two other major components, hemicellulose and lignin. The fibres are elongated tube-like cells, up to four millimetres in length and 0.04 millimetres in diameter. Aligned with the length of the tree, these hollow cells provide not only the building structure, but the circulatory system for the sap. The hemicellulose, a white starch-like substance, is deposited primarily in the cell wall and provides stiffening reinforcement. The lignin, a complex amorphous polymer, is located mainly between the fibres, binding the whole structure together.

Early attempts to obtain fibres from wood were based on mechanical grinding to produce what is called groundwood or mechanical pulp. The process causes damage to the fibres so that only relatively weak paper — i.e., newsprint — can be made from such pulp.

This led to the development of chemical pulping in which wood, cut into small chips, is pressure cooked with chemicals to degrade and dissolve the lignin and hemicellulose. The cellulose fibres then are separated easily and, if required, bleached to remove traces of lignin, coloured brown by the action of the alkaline pulping liquor.

Most chemical pulping involves the use of sulphur, which gives rise to odorous waste products detectable by humans at the level of five parts per billion of air. New pulping processes which avoid the use of sulphur and thus don't have the odour are being probed by researchers in British Columbia and elsewhere.

Mechanical pulping produces ultra-high yield pulps since practically the whole log is converted to pulp. Research has brought an alternate system, called thermo-mechanical pulping, in which the wood is first chipped and the chips then disintegrated to fibres in a process carried out at a temperature high enough to soften the lignin. A much improved product can be obtained. This process is technically in its infancy and further research may show it to be the preferred route towards high-quality, high-yield pulp.

24. What is the main problem for research in pulp and paper?

- 5 A) To develop a substitute for hemicellulose
 59 B) To reduce waste and pollution in the pulping process
 13 C) To improve the quality of paper
 5 D) To find ways of better understanding hydrogen bonding

6 E) I don't know.

M = 60
 F = 58

(S)

Rate the following statements according to this key.

- KEY A) The statement is true according to the pamphlet extract
 B) The statement is false according to the pamphlet extract
 C) You cannot decide from the pamphlet extract whether the statement is true or false.

D) I don't know.

25. British Columbia pulp mills use the thermo-mechanical pulping system.

- 30 A) M = 26
 22 B) F = 18
 36 C) (W)

5 D)

26. Heat, pressure, and chemicals are used to make pulp from wood.

- 78 A) M = 79
 10 B) F = 76
 8 C) (VS)

3 D)

27. Hemicellulose is added to pulp for stiffening and reinforcement.

- 47 A) M = 43
 39 B) F = 36
 8 C) (W)

5 D)

28. Using a light meter, a student finds that more light shines on her desk when using two 15 watt fluorescent tubes than when using one 60 watt incandescent bulb. Which of the following explains this?

- 12 A) The two fluorescent tubes use more energy than the incandescent bulb. M = 55
 45 B) The two fluorescent tubes are more efficient than the incandescent bulb. F = 36
 3 C) The incandescent bulb is more efficient than the two fluorescent tubes. (W)
 21 D) Two light sources give better light than one.

10 E) I don't know.



B.C. Government Air Photo

29. What geological features are shown in the above picture?

- 14 A) Calderas $M = 33$
 4 B) Stalactites $F = 25$
 28 C) Cirques (M)
 14 D) Meteorite craters
 39 E) I don't know.

30. The blue colour of some objects is caused by the

- 32 A) absorption of all colours except blue.
 14 B) reflection of all colours except blue.
 14 C) transformation of white light into blue light.
 5 D) absorption of all colours.
 8 E) reflection of all colours.

25 F) I don't know. $M = 36$
 $F = 28$

(W)

14

31. If a blue-black colour is produced when iodine is placed on a sample of food, the food must contain

- 7 A) proteins. $M = 92$
 7 B) minerals. $F = 96$
 63 C) starches. (S)
 4 D) fats.
 1 E) vitamins.
 17 F) I don't know.

32. The presence of ions in a given water solution is most directly detected by

- 35 A) finding out if the solution conducts electricity.
 5 B) measuring the density of the solution and comparing it with those of the pure solute and water.
 13 C) finding out if the solution has an electric charge.
 6 D) evaporating the solution and testing the residue for conductivity.
 16 E) adding an ionic substance and seeing if there is a reaction.
 25 F) I don't know. $M = 39$
 $F = 20$

(W)

33. In which of the following ways does a sample of steam differ from a sample of ice? The molecules of steam

- 3 A) move more slowly. $M = 74$
 4 B) are smaller. $F = 64$
 3 C) contain less energy. (S)
 10 D) are closer together.
 69 E) are farther apart.
 10 F) I don't know.

34. The human embryo normally develops in the

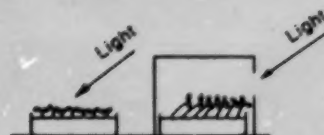
- 11 A) abdominal cavity. $M = 44$
 18 B) ovary. $F = 66$
 3 C) oviduct. (W)
 54 D) uterus.
 5 E) vagina.
 7 F) I don't know.

35. The carburetor of a gasoline engine

- 4 A) produces sparks in the cylinders. $M = 82$
 12 B) is the combustion chamber. $F = 24$
 51 C) helps to mix gasoline vapour and air. (M)
 5 D) purifies and heats the gasoline.
 6 E) regulates the order in which sparks are produced in the cylinders.
 20 F) I don't know.

15

Two similar boxes of soil were sown with the same kind of seeds and placed side by side in a greenhouse. One was covered with a light-tight box which had a small "window" cut in one side. The drawings show the appearance of the two sets of seedlings after a few days.



36. What is the best conclusion from this experiment?

- 5 A) The seedlings grow quicker if they are stimulated by light. $M = 42$
 36 B) Seedlings grow towards the light. $F = 44$
 43 C) Seedlings grow quicker in limited light and they bend towards the light. (W)
 8 D) Seedlings illuminated on one side bend towards that side.
 4 E) Light slows down the rate of growth of that part of the stem on which it falls.
 2 F) I don't know.

37. If you were carrying out tests to see which of two new drugs was better for curing a disease, which of the following factors (variables) would be most important to hold constant?

- 1 A) The colour of the drugs $M = 52$
 1 B) The shape of the pills $F = 54$
 5 C) The time of day the drugs were taken (W)
 23 D) The amount of the two drugs taken
 4 E) I don't know.

The drug nescapine is used to control coughing. Two different brands of cough tablets are advertised:

Brand 1 — Each tablet contains 10 mg of nescapine as the only active ingredient, and users are advised to take three tablets every four hours. 50 tablets cost \$2.50.

Brand 2 — Each tablet contains 14 mg of nescapine as the only active ingredient, and users are advised to take two tablets every four hours. 50 tablets cost \$5.20. Brand 2 is advertised as "extra strength".

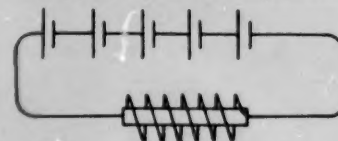
38. If a person wanted to take tablets for a bad cough, which brand would be the better choice?

- 20 A) Brand 1 because they are cheaper. $F = 26$
 24 B) Brand 2 because they are extra strength. $M = 14$
 31 C) It would depend on how bad the cough was. (W)
 19 D) It would be necessary to try them to decide.
 4 E) I don't know.

209

16

A student did an experiment to see how many paper clips an electromagnet would pick up when there were five batteries in the circuit as shown in the diagram below.



He repeated the experiment three times and these were his results:

Results

Trial	No. of paper clips picked up
1.	9
2.	7
3.	5

39. Since these results vary quite a bit, how could the student best get a more accurate result?

- 4 A) Take one more reading and see to which of the three it is nearest. $M = 63$
 61 B) Take several more readings and average the results. $F = 59$
 24 C) Average the three results he already has. (S)
 5 D) Try it with more batteries.
 5 E) I don't know.

40. Bubble-Pop and Zing are two brands of orange drink. A test was done by a market researcher on 120 people who said they were regular Zing drinkers. Each person was blindfolded and then given a glass of Bubble-Pop and a glass of Zing. They were asked which drink they liked better. A newspaper advertisement later reported that "Just over half of the Zing drinkers who stated a preference chose Bubble-Pop." What does this probably mean?

- 13 A) Bubble-Pop tastes better than Zing. $M = 58$
 14 B) More people like Bubble-Pop than Zing. $F = 60$
 11 C) When blindfolded, people like Bubble-Pop better than Zing. (M)
 59 D) There is little taste difference between Bubble-Pop and Zing.
 2 E) I don't know.

41. For which of the following can coal be used?

- KEY: 1. making chemicals
 2. making steel
 3. making electricity
- 12 A) 1 only $M = 37$
 24 B) 2 and 3 $F = 24$
 18 C) 3 only
 31 D) 1, 2 and 3 (W)
 15 E) I don't know.

17

210

42. Soap in water helps to dissolve dirt by

- 3 A) bringing the dirt into contact with the air in the soap bubbles.
- 21 B) changing the chemical composition of the dirt particles.
- 17 C) acting as an acid.
- 11 D) surrounding the dirt particles.
- 26 E) liquefying the dirt.

15 F) I don't know.

M = 16
F = 15

(W)

43. A stream which is deepening its valley in an area not previously eroded is considered to be

- 10 A) old. M = 56
- 12 B) mature. F = 45
- 14 C) rejuvenated. (M)
- 51 D) young.

12 E) I don't know.

44. In the process of photosynthesis, plants use

- 25 A) water and oxygen. M = 50
- 12 B) sugar and carbon dioxide. F = 45
- 4 C) amino acid and nitrogen. (M)
- 48 D) carbon dioxide and water.

9 E) I don't know.

45. The best type of soil for most crops is

- 3 A) clay. M = 41
- 4 B) sand. F = 33
- 30 C) river bottom. W
- 51 D) loam.
- 9 E) sandy clay.

15 F) I don't know.

46. A student wrote the following note on a laboratory project:

"Using a cork-borer I obtained several cylinders from a large potato. The cylinders were 7 cm long and 0.5 cm in diameter. I kept them on a dry plate and measured them again on the following day. I found that all of them had become shorter and thinner."

The student then put the cylinders into a beaker of tap water and wrote:

"If I measure them tomorrow I shall find that they have all returned to their original size."

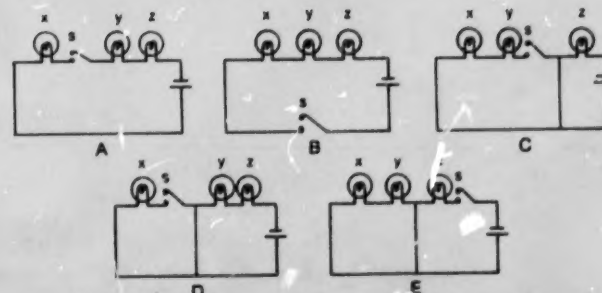
In writing this last sentence, the student was

- 5 A) making a statement of fact. M = 46
- 8 B) making an observation. F = 42
- 32 C) drawing a tentative conclusion. (M)
- 5 D) describing an experimental procedure.
- 44 E) making a hypothesis.

5 F) I don't know.

18

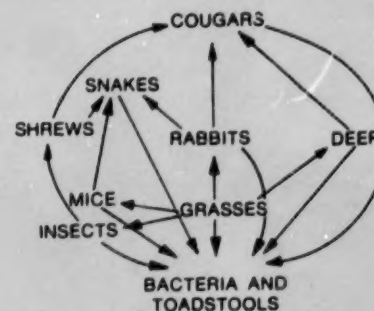
211



47. In the diagrams above X, Y, and Z represent three lamps in a circuit, which also includes a battery and a switch S. When the switch is open X fails to light while Y and Z do light. Which one of the following circuits is it?

- 13 A) M = 68
- 4 B) F = 45
- 5 C) (M)
- 54 D)
- 2 E)

18 F) I don't know.



48. The only producers shown in the food web at the left are

- 46 A) grasses. M = 44
- 13 B) toadstools. F = 48
- 5 C) mice. (W)
- 5 D) deer.

19 E) I don't know.

49. In breaking down rocks into soil, wind is most effective when it

- 7 A) is cool. M = 72
- 9 B) is warm. F = 60
- 3 C) moves slowly. M
- 66 D) carries sand.

10 E) I don't know.

19

212

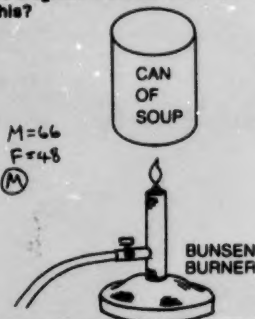
161

50. The particles most directly involved in forming chemical bonds are

- 50 A) electrons. $M = 54$
 11 B) neutrons. $F = 46$
 2 C) photons. (M)
 1 D) positrons.
 10 E) protons.

22 F) I don't know.

51. An unopened can of soup is heated as shown in the diagram. If the can bursts, which of the following is most important in accounting for this?



- 15 A) The can gets hot and expands. $M = 66$
 57 B) Some of the water in the soup changes to steam. $F = 48$ (M)
 9 C) The air in the can absorbs heat
 3 D) The metal gets hot and starts to shrink.
 4 E) I don't know.

52. In terms of the theory of natural selection, why do giraffes have such long necks?

- 1-53 1 A) Stretching to get food in high trees has made their necks longer.
 2-54 4 B) There is something inside of giraffes which keeps making longer necks.
 5 C) Giraffe food contained vitamins which caused the vertebrae to lengthen.
 5 D) Giraffe necks have gotten longer and longer as time has gone on, but nobody has any idea why this is.
 53 E) Giraffes born with the longest necks have been able to stay alive when food was scarce and have passed this trait on to their offspring.
 4 F) I don't know.

53. When some pink food colouring is dissolved in water, the water turns pink. The best explanation for this is that all

- 5 A) substances are composed of atoms. $M = 45$
 43 B) substances are composed of molecules which move. $F = 41$ (M)
 6 C) molecules are very close together.
 16 D) molecules are composed of atoms which move.

25 E) I don't know.

213

20

54. The purpose of a fuse or circuit breaker is to

- 5 A) turn lights on and off. $M = 69$
 51 B) to protect circuits from carrying too much electricity. $F = 35$
 4 C) to protect people from getting electric shocks. (W)
 4 D) to save electricity from being wasted.
 26 E) to regulate the number of volts in the circuit.
 6 F) I don't know.

55. A radio-active substance has a half life of 6 days. What fraction of the original activity of a sample remains after 12 days?

- 27 A) None of it $M = 36$
 5 B) $1/36$ $F = 22$
 7 C) $1/12$ (W)
 29 D) $1/4$
 11 E) $1/2$

19 F) I don't know.

56. In discussing the problem of nuclear proliferation, a famous scientist declared that Canada must provide more Candu reactors for developing countries. What is the best evaluation we can give to this scientist's statement?

- 5 A) His conclusion is probably right, since he approaches the problem with a scientific attitude. $M = 59$
 4 B) His conclusion is probably wrong, because scientists seem to be trying to destroy the world. $F = 55$
 8 C) His conclusion and reasons are probably correct, because scientific results are the most reliable kind. (M)
 57 D) His conclusion and reasons should be weighed according to his knowledge of international affairs.

22 E) I don't know.

57. Which of these concepts can be used to explain why a driver who is not wearing a seat belt may be thrown through the windshield if his car stops suddenly?

- 9 A) Buoyancy $M = 59$
 9 B) Friction $F = 34$
 19 C) Potential energy (M)
 47 D) Inertia
 5 E) Mechanical advantage

9 F) I don't know.

21

214

58. A chemistry textbook states that a certain element has an atomic number of 6 and an atomic weight of 12. This means that there must be

- 9 A) 12 neutrons in the nucleus of the element.
- 6 B) 12 electrons in the nucleus of the element.
- 7 C) 12 protons in the nucleus of the element.
- 32 D) 6 protons and 6 neutrons in the nucleus of the element.
- 17 E) 6 protons and 6 electrons in the nucleus of the element.

30 F) I don't know. $M = 34$
 $F = 30$

(M)

59. Scientists are skeptical that Earth has been visited by beings from outside the solar system because

- 4 A) there is no life anywhere in the Universe except on Earth.
- 37 B) the distances between stars are enormous.
- 3 C) only crackpots believe in such nonsense.
- 46 D) few places outside the solar system can support life.

$M = 49$

$F = 26$

(W)

6 E) I don't know.

60. Four balls, P, Q, R, and S shown to scale in the figures, are made of different materials but have the same mass.



Which one of the following statements about their densities is true?

- 10 A) They all have the same density.
- 11 B) You cannot know anything about their densities.
- 13 C) Which one has the highest density depends on how the volumes are measured.
- 8 D) P has the highest density.
- 31 E) R has the highest density.

$M = 49$

$F = 28$

(M)

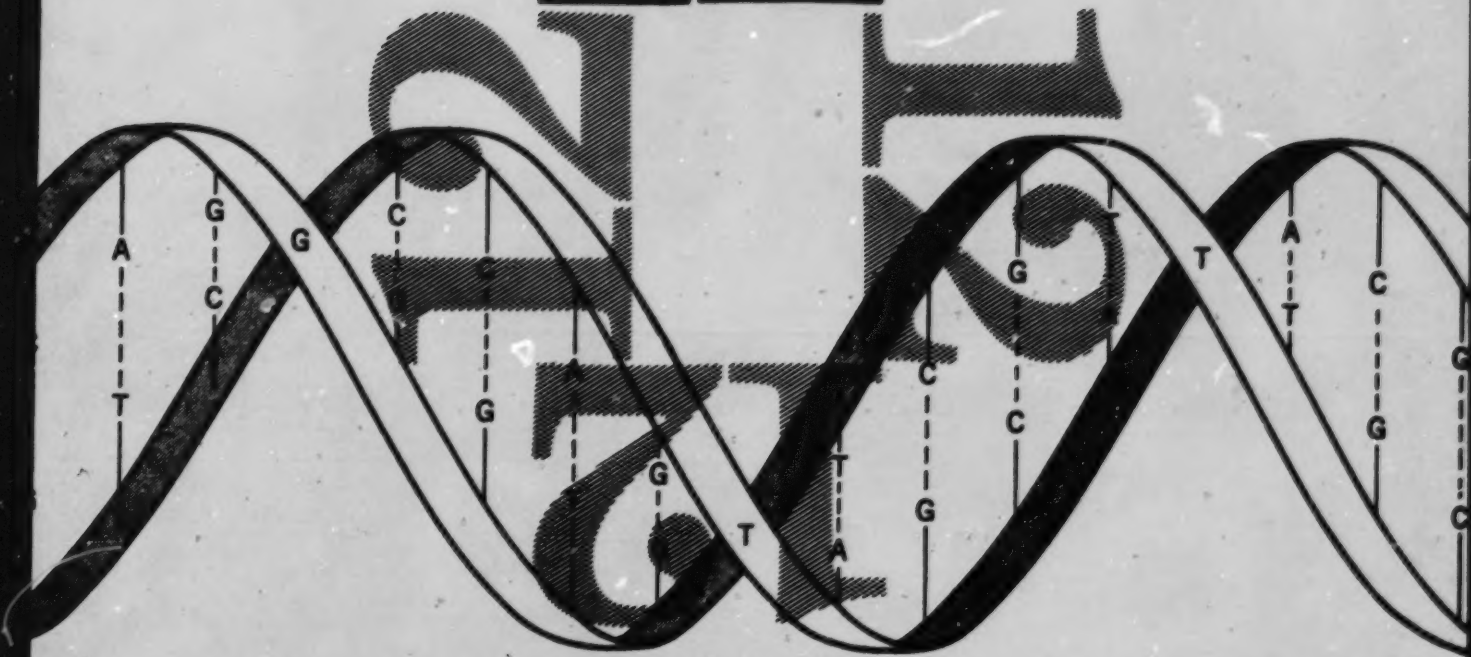
F) I don't know

SCIENCE ASSESSMENT

GRADE

12

Booklet B



The purpose of this assessment is to find out how well Grade 12 students have learned some of the important skills in Science. The results of the survey will be used by teachers in your district and throughout the province in designing new Science programs. We therefore ask for your co-operation in helping us plan for the future. Depending on your Science background, the questions on this test may be easy or they may be difficult. Regardless of the courses you have taken, it is important that you answer each question as carefully as you can. Thank you for the time and effort you put into this assessment.

INSTRUCTIONS

There are several choices available for each question, including "I don't know". Select the ONE best answer in each case, and mark it on your card. If you have no idea of the correct answer, mark the oval corresponding to "I don't know". Be sure to use the pencil that is provided.

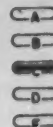
Example:

How many months are there in a year?

- A) 10
- B) 52
- C) 12
- D) 24

E) I don't know.

Your answer should be response C, as shown:



IF YOU MAKE A MISTAKE, ERASE THE WRONG MARK COMPLETELY

BLACKEN THE OVAL ON YOUR ANSWER CARD
THAT CORRESPONDS TO YOUR ANSWER

1. What is your date of birth?

- Year A) 1957 or earlier
B) 1958
C) 1959
D) 1960
E) 1961
F) 1962
G) 1963 or later
- Month A) January
B) February
C) March
D) April
E) May
F) June
G) July
H) August
I) September
J) October
K) November
L) December

2. Sex:

- A) Male
B) Female

3. How many minutes per week on the average do you spend on science homework?

- A) I do not take a science course
B) None at all
C) Less than 30
D) 30 to 60 minutes per week
E) 60 to 90 minutes per week
F) More than 90 minutes per week

4. Which of the following have you successfully completed? (More than one answer is possible)

- A) Science 8
B) Science 9
C) Science 10
D) Biology 11
E) Biology 12
F) Chemistry 11
G) Chemistry 12
H) Physics 11
I) Physics 12
J) Other Science

5. Which courses are you taking now?

- A) Science 8
B) Science 9
C) Science 10
D) Biology 11
E) Biology 12
F) Chemistry 11
G) Chemistry 12
H) Physics 11
I) Physics 12
J) Other Science

6. If you have a job, how many hours per week do you spend on it?

- A) Less than 5 hours
B) 5-10 hours
C) 10-20 hours
D) More than 20 hours
E) I do not have a part-time job

7. What is the highest level of education completed by your father or guardian?

- A) Elementary school
B) Junior secondary school
C) Senior secondary school
D) Trade or vocational school
E) Technical training or some university study
F) Completed Bachelor's degree
G) Completed post-graduate degree
H) I don't know

8. What is the highest level of education completed by your mother or guardian?

- A) Elementary school
B) Junior secondary school
C) Senior secondary school
D) Trade or vocational school
E) Technical training or some university study
F) Completed Bachelor's degree
G) Completed post-graduate degree
H) I don't know

9. What do you plan to do after leaving secondary school?

- A) Look for a job
B) Business school
C) Vocational, art or trade training
D) Technical institute
E) Community college: university transfer program
F) Community college: career program
G) University
H) Take a year off and then return to an educational program
I) Take a year off and then look for a job
J) Other plans
K) Undecided

10. What is the main reason for your answer to Question 9?

- A) Parents' wishes
B) Personal ambition
C) Tired of schooling
D) Want more education
E) Best I can hope for
F) Friends are making the same choice
G) Strong personal interest
H) Don't like other choices
I) Financial reasons
J) Other reasons

11. What is your father's or guardian's occupation? (Choose the best answer).

- A) Clerical (clerk, secretary, etc.)
B) Deceased
C) Farmer (own farm)
D) Managerial (own business, company manager, executive)
E) Mining, logging, fishing, farm work
F) Professional (doctor, lawyer, teacher, graduate engineer)
G) Retired
H) Sales (retail business, insurance, real estate)
I) Semi-skilled work (factory, mill worker)
J) Service (armed forces, police, motel employee)
K) Skilled worker (construction, production, tradesman)
L) Technical (technologist, electronic technician)
M) Transport, communication (telephone, bus, newspaper)
N) Unskilled worker (labourer)
O) Homemaker
P) Other

12. What is your mother's or guardian's occupation? (Choose the best answer).

- A) Clerical (clerk, secretary, etc.)
B) Deceased
C) Farmer (own farm)
D) Managerial (own business, company manager, executive)
E) Mining, logging, fishing, farm work
F) Professional (doctor, lawyer, teacher, graduate engineer)
G) Retired
H) Sales (retail business, insurance, real estate)
I) Semi-skilled work (factory, mill worker)
J) Service (armed forces, police, motel employee)
K) Skilled worker (construction, production, tradesman)
L) Technical (technologist, electronic technician)
M) Transport, communication (telephone, bus, newspaper)
N) Unskilled worker (labourer)
O) Homemaker
P) Other

13. Write the code number for your school in the space provided on your answer card.

1. An astronaut is able to jump higher on the Moon than on the Earth. Which of the following is the best explanation of this?

- 6 A) His mass is less when he is on the Moon. $M = 88$
 7 B) The force of gravity is less on the Moon than on the Earth. $F = 80$
 8 C) His distance from the Earth is greater when he is on the Moon. (ST)
 9 D) There is no air on the Moon to offer resistance.
 10 E) Newton's Laws of Motion do not apply on the Moon.
 11 F) I don't know.

2. Heating a mixture of powdered iron and sulphur will result in the formation of

- 5 A) a single element. $M = 51$
 6 B) two other elements. $F = 48$
 7 C) a solution. (M)
 8 D) an alloy.
 9 E) a compound.
 10 F) I don't know.

3. What is the main way that sweating helps your body?

- 3 A) It keeps your skin moist.
 4 B) It keeps you from catching cold. $M = 66$
 5 C) It rids your body of extra water. $F = 57$
 6 D) It gets rid of the salt in your body.
 7 E) It aids in controlling body temperature. (M)
 8 F) I don't know.

4. Which makes use of the magnetic lines of force around an electric current?

- 11 A) A compass $M = 25$
 12 B) A dry cell $F = 6$
 13 C) A storage battery (W)
 14 D) An electric toaster
 15 E) A telephone receiver
 16 F) I don't know.

5. The distinctive shape of cucumbers is due primarily to

- 3 A) natural chemicals in the soil. $M = 53$
 4 B) hereditary character of the seed. $F = 86$
 1 C) amount of fertilizer applied. (ST)
 3 D) temperature during the growing season.
 8 E) I don't know.

6. This is a photograph of a valley in British Columbia. What process was the main cause of this valley?

- 4 A) Glacial action $M = 69$
 12 B) River erosion $F = 67$
 2 C) Lava flow (VS)
 4 D) Earthquake action
 3 E) I don't know.



B.C. Government Air Photo

7. Which of the following products can be made from wood?

- 1 Paper 2 Disinfectants 3 Alcohol
 56 A) 1 only $M = 16$
 28 B) 1 and 3 $F = 10$
 1 C) 2 only (W)
 13 D) 1, 2, and 3
 1 E) I don't know.

Items 8 through 13 on the opposite page refer to the data below.

Five test tubes were set up as follows:

- (i) Each contained one gram of protein.
- (ii) All substances were dissolved in water.
- (iii) All test tubes were kept at 37°C.
- (iv) For test tube E, substance X was boiled and then cooled before it was added to the protein.

Test Tube	Content of Tubes	Amount of substance W present after 24 hours
A	Protein + Substance X	0.05 gram
B	Protein + Water	0.00 gram
C	Protein + Substance X + Hydrochloric acid	0.08 gram
D	Protein + Hydrochloric acid	0.00 gram
E	Protein + Substance X (boiled)	0.00 gram

222

8. Which test tube acts as a control (comparison) for the entire experiment?

- 14 A) M = 52
- 51 B) F = 50
- 7 C) (M)
- 1 D) (M)
- 7 E)

19 F) I don't know.

9. Which test tube gives evidence that protein does not break down spontaneously into Substance W?

- 11 A) M = 22
- 21 B) F = 20
- 20 C) (W)
- 9 D) (W)
- 11 E)

27 F) I don't know.

10. Which test tube gives evidence that acid accelerates the activity of Substance X?

- 2 A) M = 63
- 1 B) F = 61
- 61 C) (S)
- 13 D)
- 3 E)

F) I don't know.

11. Which test tube is the control for item 10 above?

- 18 A) M = 15
- 5 B) F = 15
- 10 C) (W)
- 39 D)
- 4 E)

14 F) I don't know.

12. Which test tube gives evidence that Substance X is a substance whose properties can be destroyed?

- 4 A) M = 57
- 3 B) F = 57
- 9 C) (M)
- 6 D) (M)
- 51 E)

20 F) I don't know.

TURN OVER YOUR ANSWER CARD

13. Which test tube is the control for item 12 above?

- 43 A) M = 42
- 1 B) F = 43
- 5 C) (M)
- 2 D) (M)
- 8 E)

24 F) I don't know.

223

14. Solid materials which are good conductors of electricity have many loosely bound

- 9 A) neutrons. $M = 72$
 7 B) protons. $F = 66$
 69 C) electrons. (VS)
 0 D) nuclei.
 10 E) I don't know.

15. The chief function of the kidneys is

- 3 A) respiration. $M = 68$
 1 B) regulation of temperature. $F = 54$
 30 C) elimination of solid wastes. (M)
 41 D) cleaning the blood.
 4 E) I don't know.

16. The particles that make up atoms are usually said to be

- 4 A) protons and electrons only. $M = 78$
 10 B) protons and neutrons only. $F = 76$
 71 C) protons, neutrons, and electrons. (VS)
 1 D) alpha, beta, and gamma rays.
 1 E) alpha particles and beta particles only.
 6 F) I don't know.

17. The serving of reheated meat in restaurants is often discouraged and sometimes is prohibited by law. Which of the following is the main reason for this?

- 1 A) Most people do not like it. $M = 74$
 2 B) Valuable mineral salts are lost on reheating. $F = 74$
 1 C) It is expensive to heat food twice. (S)
 74 D) Bacteria will multiply quickly on warm meat.
 18 E) Reheating causes a reduction in protein content.
 3 F) I don't know.

18. A man whose blood type is OA marries a woman whose blood type is OB. Their offspring could not have which of the following blood types?

- 49 A) AA. $M = 46$
 11 B) AB. $F = 50$
 2 C) OA. (M)
 2 D) OB.
 14 E) OO.
 18 F) I don't know.

19. It has often been said that published reports of scientific research are generally very accurate and honest.

- 1 A) This is true because scientists are very accurate and honest people. $M = 61$
 5 B) This is true because only one answer can be correct in science. $F = 63$
 41 C) This is true because reported results can be checked by other scientists. (S)
 24 D) There is little basis for this claim.
 7 E) I don't know.

20. An example of a scientific model is: "The atom is like a miniature solar system composed of electrons in orbits, and, in the centre, a nucleus containing protons and neutrons." Which one of the following statements about scientific models is not correct?

- 22 A) They are man-made constructs and may not represent reality. $M = 25$
 15 B) They consist of a relatively small number of assumptions. $F = 19$
 22 C) They represent what scientists could see with very powerful instruments. (W)
 14 D) They are tentative and may be modified or discarded.
 23 E) I don't know.

21. A coal-burning electric power plant is proposed in your area. The power plant will reduce the cost of electricity as well as prevent future power failures. It will also discharge heat into the environment and cause some air pollution. What should be done?

- 1 A) Build it. You can save money. $M = 86$
 1 B) Build it. It will be good for your community. $F = 88$
 1 C) Build it. You will have all the electricity you need. (ST)
 6 D) Don't build it since it will pollute the water and air.
 87 E) Don't build it without first determining the effect on the environment.
 3 F) I don't know.

22. Atmospheric carbon dioxide is believed to be increasing due to

- 16 A) decreased carbon dioxide fixation by green plants. $M = 49$
 2 B) increased release from volcanoes. $F = 34$
 41 C) increased burning of fossil fuels. (W)
 24 D) cutting down of too many trees.
 16 E) I don't know.

23. Which of the following would be the safest place to be during a thunderstorm?

- 8 A) Near a lake. $M = 43$
 7 B) Under a tree. $F = 39$
 39 C) In an open field. (M)
 41 D) In an automobile.
 4 E) I don't know.

Carefully read the following report condensed from a magazine and answer the questions on the following page.

The Medical Research Council of Canada (MRC) has adopted strict guidelines on conducting recombinant DNA research. It seems certain that the Canadian government will ensure that recombinant DNA experiments must be conducted according to the MRC guidelines.

Recombinant DNA research involves the rearrangement of genetic material from cells and viruses.

Dr. Siminovitch of the University of Toronto says the only certain outcome of this technique will be a better understanding of how genes function. But he is convinced that one day scientists will be able to make large amounts of badly needed insulin and growth hormones in the laboratory. At present, supplies of both are limited.

Other possible uses involve creating new forms of life. For instance, some plants can convert nitrogen from the atmosphere to protein and do not need nitrate fertilizers. If this ability could be transferred to other plants (wheat, for instance) the need for expensive nitrate fertilizers would be eliminated, and many world food problems would be eased.

Dr. Friesen of York University plans to use the recombinant DNA technique to explore the causes of cancer.

One fear of recombinant DNA research is that a 'bug' will escape from the laboratory and cause some deadly disease. Dr. Friesen says these fears can be laid to rest since MRC guidelines "will be effective" in preventing the escape of the new organisms from laboratories.

Jonathan King, an American scientist, disagrees with Dr. Friesen. He says the facilities that he has seen in the U.S. will not prevent the escape of micro-organisms.

The bacteria *E. coli*, which grows in the human intestine, plays a large part in this research. In the laboratory, a weakened strain of *E. coli* which will not survive outside the laboratory is used. But Dr. King notes that this weakened strain "is not dead" and might be able to survive in the human body. David Suzuki asks if a cancer-causing gene could "unwittingly" be inserted into *E. coli*, escape from the laboratory and cause an epidemic of cancer 20 or 30 years later.

Scientists are now working only with bacteria and viruses. They have not succeeded in performing the same experiments with more complex organisms. They cannot develop "Frankenstein-like monsters in their labs at night". However, there is no reason, in theory, to suppose that this will not be possible one day.

Question: Rate each of the four statements below according to the following key:

- KEY:
- A) According to the report, the statement is true.
 - B) According to the report, the statement is false.
 - C) You cannot decide from the report whether the statement is true or false.
 - D) I don't know.

24. Statement: Recombinant DNA research has eliminated the need for nitrogenous fertilizers.

- 27 A) M = 43
40 B) F = 36
24 C) (W)
7 D)

25. Statement: Recombinant DNA research will lead to better understanding of how genes function.

- 74 A) M = 72
6 B) F = 75
10 C) (VS)
5 D)

26. Statement: Recombinant DNA research has resulted in the spread of *E. coli* bacteria.

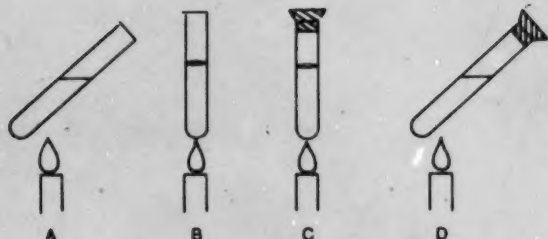
- 10 A) M = 62
64 B) F = 62
20 C) (S)
6 D)

27. Statement: Recombinant DNA research is safe if done under MRC guidelines.

- 44 A) M = 39
10 B) F = 37
31 C) (W)
7 D)

28. Which of the following is the most urgent problem with regard to recombinant DNA research?

- 74 A) Ensuring that controls are effective and enforced M = 71
5 B) Keeping scientists from fooling with nature in this way F = 76
3 C) Keeping government from interfering in scientific research (S)
10 D) Making sure scientists don't create monsters in their laboratories
8 E) I don't know.



29. Which is the correct method of heating a liquid in a test tube?

- 74 A) $M = 76$
 10 B) $F = 71$
 1 C) $\textcircled{S}$
 12 D)
 2 E) I don't know.

30. When diluting an acid, which is the correct procedure?

- 21 A) Add water to acid. $M = 34$
 12 B) Add acid to water. $F = 21$
 13 C) Add water to one-half of the acid and then add the remainder of the acid. $\textcircled{W}$
 10 D) Pour acid and water together into an empty beaker.
 16 E) I don't know.

31. If acid is spilled on your skin, what should be done immediately?

- 6 A) Pour alkali on the affected part. $M = 84$
 94 B) Wash the affected part with water. $F = 83$
 1 C) Cover the affected part with a dry sponge. $\textcircled{VS}$
 3 D) Apply antiseptic cream to the affected part.
 5 E) I don't know.

32. If the Earth's axis were to be tipped at an angle of 10° instead of 23° , which of the following would be true?

- 5 A) The year would be longer than at present. $M = 58$
 11 B) There would be only half as many hours of daylight in a year as at present. $F = 38$
 2 C) We would be able to see both sides of the Moon. $\textcircled{S}$
 2 D) The Moon would appear to be motionless rather than appearing to move in the sky.
 41 E) None of the above would be true.
 71 F) I don't know.

33. The determiners of hereditary characteristics that pass from generation to generation are called

- 1 A) cells. $M = 60$
 13 B) chromosomes. $F = 69$
 1 C) nuclei. $\textcircled{S}$
 1 D) mutants.
 71 E) genes.
 2 F) I don't know.

34. A certain force was needed to keep a skateboard moving along a horizontal surface at a uniform velocity. This indicates that

- 14 A) the skateboard had inertia. $M = 25$
 5 B) the skateboard had weight. $F = 29$
 27 C) the friction forces acting on the skateboard were equal to the force applied. $\textcircled{W}$
 29 D) the friction forces acting on the skateboard were just less than the force applied.
 6 E) the skateboard had mass.
 17 F) I don't know.

35. Green plants are important to animals because the plants

- 5 A) consume both food and oxygen. $M = 59$
 7 B) consume food and give off oxygen. $F = 72$
 4 C) consume food and give off carbon dioxide. $\textcircled{M}$
 66 D) produce food and give off oxygen.
 15 E) produce food and give off carbon dioxide.
 3 F) I don't know.

36. Chemical equilibrium occurs only when

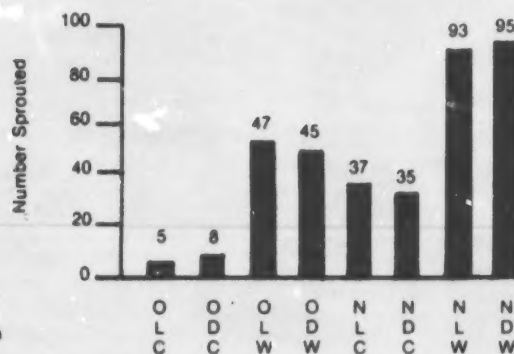
- 11 A) all components stop reacting. $M = 24$
 9 B) the substances initially present have now reacted completely. $F = 17$
 3 C) the substances start reacting. $\textcircled{W}$
 21 D) the components decompose at the same rate as they are formed.
 25 E) the concentration of all the components become equal.
 30 F) I don't know.

37. A certain machine is said to be 50 per cent efficient. What does this mean?

- 1 A) The machine is not useful for the task performed. $M = 54$
 9 B) The machine operates with no loss of energy 50 per cent of the time. $F = 48$
 51 C) Only 50 per cent of the work put into the machine is returned as useful work done. $\textcircled{A}$
 9 D) 50 per cent of the energy put into the machine is destroyed.
 10 E) Only 50 per cent of the work put into the machine can be measured as energy.
 10 F) I don't know.

This is a graph of the results of an experiment. 400 seeds that were 10 years old and 400 new seeds were planted in good soil and watered each day.

100 old seeds and 100 new seeds were put in a dark, cool place.
100 old seeds and 100 new seeds were put in a light, cool place.
100 old seeds and 100 new seeds were put in a dark, warm place.
100 old seeds and 100 new seeds were put in a light, warm place.



Five things which may affect the growth of seeds are: water, heat, soil, age, and light.

38. Which of the above were tested?

- 71 A) Heat, age, and light M = 69
4 B) Soil, heat, and light F = 72
16 C) Heat, soil, age, and light (S)
2 D) Water and soil
1 E) Water and age
6 F) I don't know.

16

230

39. Look at the graph again. Here are some things you can see on the graph:

- 365 seeds sprouted.
- 400 seeds were 10 years old.
- 400 seeds were new.
- 400 seeds were kept cool.
- 400 seeds were kept warm.
- 400 seeds were kept in the light.
- 400 seeds were kept in the dark.

Which one happened because of all the others?

- 57 A) 1 M = 56
5 B) 2 F = 58
3 C) 4 (M)
4 D) 6
3 E) 7

26 F) I don't know.

40. Look at the graph again. Here are five statements about this experiment:

- 15 1. More new seeds sprout than old seeds. M = 48
20 2. Heat makes a difference in how many seeds sprout. F = 50
4 3. Light makes a difference in how many seeds sprout. (M)
4 4. Water does not make a difference in how many seeds sprout.
49 5. Light does not make a difference in how many seeds sprout.

Which of these statements can you find from the graph?

- A) 1 only
B) 1, 2, and 4
C) 4 and 5
D) 3 and 4
E) 1, 2, and 5
F) I don't know.

41. Look at the graph again. Listed below are some other experiments you could do. Which one is not based on the experiment shown in the graph?

- 7 A) A study of seeds of several ages M = 49
8 B) A study of the effect of different numbers of hours of light and dark on seeds F = 50
50 C) A study of the heights of plants (M)
20 D) A study of the effect of different amounts of water on seeds
6 E) A study of the effect of different temperatures on seeds
7 F) I don't know.

42. Look at the graph again. Why were 800 seeds used?

- 12 A) 800 makes 8 groups of exactly 100 each, and 100 is a round number. M = 67
5 B) Experiments require exactly 100 samples in each group. F = 76
2 C) 800 were all the seeds that were available. (VS)
11 D) The groups needed to be large enough so that what was found out was not wrong due to chance.
3 E) 800 happened to be the number taken out of the bag.
6 F) I don't know.

17

231

43. Which of the following is produced when a candle burns?

- 13 A) Carbon atoms in the same crystal form as diamonds
 10 B) Hydrogen gas $M = 26$
 15 C) Nitrogen gas $F = 16$
 10 D) Oxygen gas (W)
 11 E) Water vapour
 21 F) I don't know.

44. Over-logging can lead to which of the following?

- 1 Erosion
 2 Loss of nutrients in soil
 3 Marked decrease in global oxygen

- 9 A) 1 only $M = 36$
 9 B) 2 only $F = 22$
 14 C) 1 and 2 (W)
 15 D) 1 and 3
 30 E) 1, 2, and 3
 11 F) I don't know.

45. When 2 g of zinc and 1 g of sulphur are heated together, practically no zinc or sulphur remains after the compound zinc sulphide is formed. What happens if 2 g of zinc are heated with 2 g of sulphur?

- 14 A) Zinc sulphide containing approximately twice as much sulphur is formed. $M = 40$
 37 B) Approximately 1 g of sulphur will be left over. $F = 33$
 6 C) Approximately 1 g of zinc will be left over. (W)
 6 D) Approximately 1 g of each will be left over.
 8 E) No reaction will occur.
 29 F) I don't know.

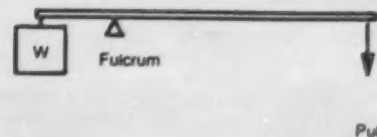
46. You find what appear to be salt (sodium chloride) deposits. In order to learn what the deposits are, which of the following items of information would be most valuable?

- 17 A) Percentage of sodium chloride in the sample $M = 39$
 2 B) Percentage of magnesium chloride in the sample $F = 38$
 4 C) Relative density of the sample (M)
 34 D) Chemical composition of the sample
 14 E) Solubility in water of the sample
 22 F) I don't know.

18

232

47. The advantage of using a lever such as that shown in the diagram to raise a weight W instead of lifting it directly is that



- 25 A) less energy is required. $M = 48$
 2 B) it is quicker. $F = 40$
 44 C) less force is needed. (W)
 4 D) less movement is needed.
 15 E) less work has to be done.
 5 F) I don't know.

48. Bill always makes good grades in school but is a practical joker. Frank also makes good grades but has no sense of humour. Janet is a serious, intelligent, and popular girl. Who would most likely become a research scientist?

- 16 A) Frank $M = 47$
 25 B) Janet
 3 C) Either of the boys $F = 54$
 51 D) Any of the three (S)
 4 E) I don't know.

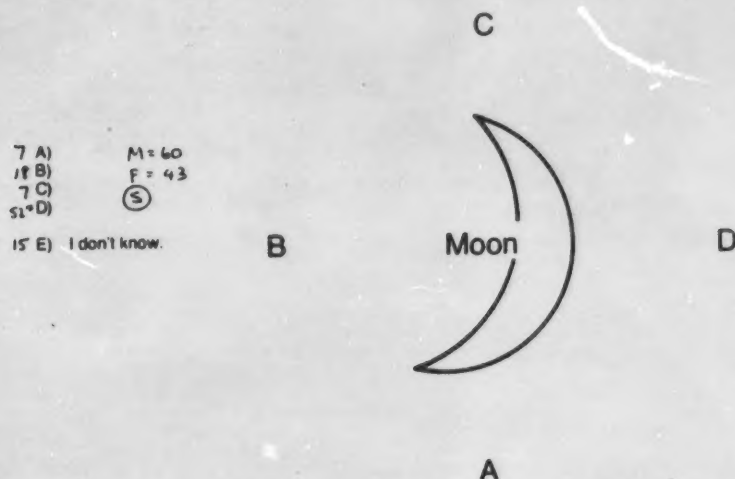
49. When many new facts are discovered which do not fit a scientific theory, scientists will usually ask themselves:

- 13 A) Shall we throw out the theory since the facts do not fit it? $M = 54$
 6 B) Can we change the facts a little so that they will fit the theory? $F = 51$
 12 C) Shall we keep the theory as it is, since these new facts don't help it? (S)
 53 D) Can we change the theory a little so that these new facts will fit it?
 12 E) I don't know.

19

233

50. In the diagram at the right, the sun would be located at position



51. If a large amount of mineral fertilizer is placed around the base of a house plant, the plant is likely to wilt and die. The best explanation for this is that

- 4 A) the plant ages more rapidly.
 4 B) the plant weakens and dies of disease.
 15 C) the amount of water in the roots has been decreased. (W)
 10 D) the plant cannot produce food because its chlorophyll has been destroyed.
 44 E) the fertilizer uses up the carbon dioxide needed by the plant to make its own food.
 21 F) I don't know.

52. If all green plants died, what would be the most important effect on man?

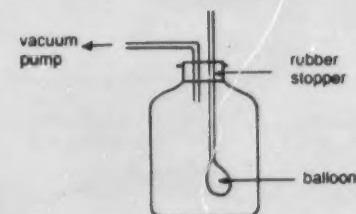
- 8 A) He would have to eat meat only.
 55 B) Sooner or later man would die of starvation. (W)
 24 C) Man would get a little sick because he couldn't get vitamins.
 1 D) Man couldn't build houses because there would be no lumber.
 3 E) The land would be bare and not very pretty for man to look at.

5 F) I don't know.

234

20

53. What happens to the balloon when the air in the bottle is extracted by a vacuum pump?



- 40 A) It increases in volume.
 10 B) It does not change in volume.
 19 C) It decreases in volume. (W)
 5 D) It decreases in volume at first but then increases.
 11 E) It is sucked into its tube.
 12 F) I don't know.

54. What is the main problem associated with the disposal of waste products from a nuclear reactor? Some of the products

- 59 A) remain radioactive for thousands of years. (M)
 3 B) are likely to explode at any time.
 11 C) can destroy the ozone layer.
 14 D) give off dangerous levels of microwaves.
 2 E) I don't know.

55. Oystermen, in trying to rid their oyster beds of starfish, dredged up many common starfish, cut each one apart, and dumped the pieces overboard. Oyster beds in this area soon had large populations of 'comet' starfish with one arm much larger than the others. Failure to rid the oyster beds of starfish was probably due to

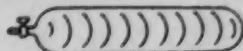
- 2 A) the invasion of a new species of starfish.
 65 B) inadequate understanding of the regenerative ability of the starfish. (S)
 6 C) rapid reproduction of 'comet' starfish to fill the place underpopulated by the removal of the common starfish.
 7 D) The appearance of a new species created by mutation to fill the place underpopulated by the removal of the common starfish.
 5 E) The fact that 'comet' starfish fed on the dead common starfish and multiplied.

11 F) I don't know.

21

235

An iron container is evacuated and weighed. Then it is filled with hydrogen gas and weighed again.



56. The mass of the container full of hydrogen compared to the mass of the evacuated container is

- 19 A) less. $M = 38$
 22 B) greater. $F = 26$
 16 C) the same. (W)
 11 D) greater or less depending on the volume of the gas in the container.
 7 E) greater or less depending on the temperature of the gas in the container.

12 F) I don't know.

57. A piece of granite has crystals about 5 mm in diameter. It was probably formed

- 10 A) in a cave. $M = 40$
 37 B) from molten rock which cooled slowly. $F = 33$
 8 C) from swiftly flowing lava. (M)
 20 D) in the sediment of a glacier.
 22 E) I don't know.

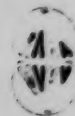
58. An investigator claims to have found a fossil human bone in rock known to be 300 million years old. This is probably

- 24 A) evidence for the theory of evolution. $M = 37$
 21 B) an important geological discovery. $F = 22$
 11 C) Neanderthal man. (W)
 29 D) a mistake or hoax.
 9 E) I don't know.

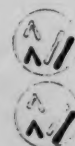
59. If a sudden change took place on the surface of the Sun, the change would first be observed on Earth after about

- 16 A) 1 second. $M = 34$
 10 B) 10 seconds. $F = 14$
 8 C) 30 seconds. (M)
 14 D) 8 minutes.
 12 E) 1 hour
 27 F) I don't know.

60. The phases of mitotic cell division shown below actually occur in which order?



1



2



3



4

- 7 A) 1, 2, 3, 4 $M = 50$
 8 B) 2, 1, 3, 4 $F = 49$
 30 C) 3, 4, 1, 2 (S)
 18 D) 4, 3, 1, 2

14 E) I don't know.

APPENDIX B
ADMINISTRATION INSTRUCTIONS FOR
GRADE 4 ACHIEVEMENT TESTS

SCIENCE ASSESSMENT 1978

GRADE/YEAR 4

ADMINISTRATION DIRECTIONS

Thank you for your co-operation in administering this Science Test. We realize that present primary science programs are quite varied and, therefore, some of the questions asked in this assessment may not seem to fit into every program. However, the information resulting will be used as baseline only. For your interest, a pamphlet outlining the uses of assessment information is enclosed with the test materials.

BEFORE THE ASSESSMENT

Because of one unique feature, this test will require the teacher supervisor to do a very careful familiarization study - all the questions (but none of the answer foils or distractors) are to be read aloud by the teacher supervisor administering the test. Each question is to be followed by a silent time sufficient for pupils to select their answers. You will note that the questions and information to be read aloud are printed in bold face type. It is suggested that you will find it useful to make a few notes on your copy of the test, for example:

1. on the first page, the instructions in the shaded portion should be read aloud. Following those instructions, after the words "I don't know", the pupils should be told "If you change your mind about an answer, be sure to erase completely the mark you do not want."

2. on page 4, you will notice that some words are printed in light-face capital letters (this occurs in several other items throughout the test). These words should be read aloud without any voice modulation or emphasis - they are printed in a different type style to draw the attention of the pupils in considering the responses.

3. on Page 8, item 15 is wrongly numbered 12.

AT THE TIME OF TESTING

- | | | | |
|---------------------|---------------------------|----------------|--------------|
| 1. Time Allocation: | Distribution of Materials | } - 10 minutes | |
| | Completion of Page 2 | | |
| | Part 1 of Test | | - 35 minutes |
| | Part 2 of Test | | - 35 minutes |

Because the test questions will be read to the student, the times suggested above should be regarded as approximate. You should ensure that all of your students are given ample time to respond comfortably to each question. Each part of the test should be administered in a separate sitting so that students may have a rest between the two parts. It is advisable to have both sittings on the same day to increase the likelihood that all pupils who write Part One also write Part Two.

When a pupil is absent for one part of the test, print the word ABSENT on the first page of that part of the test for which he or she is absent.

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NOTE: It is essential that each student retain the same booklet for parts one and two of the test.

2. Just before the testing period begins, write the school code number on the chalkboard. Please check with the Principal for this code number. You may find it convenient to write it in your copy of the test.
3. Every pupil will need to have one sharpened pencil and a clean eraser. The teacher supervisor should have a number of sharpened pencils available to take care of emergencies.
4. When all the pupils have been seated, pass out the booklets and the cardboard rulers and tell the pupils not to open the booklets until told to do so, and to place the rulers at the top of their desks, ready for use when needed. (5 minutes allotted for this).
5. Students should be informed that the purpose of the test is to find out some of the things that boys and girls in Grade/Year 4 throughout British Columbia know about science. Ask them to work as carefully and as quickly as they can. Say "I will read the questions aloud, but you must read the answer choices by yourselves." Be sure that they all understand these directions.
6. Have the students open their booklets to the Background Information section on the inside front cover. Have them write the school code number in the box.

Note there are five numbers in the code - it is suggested you repeat the code after a few moments to let pupils check their copying. Say:

"Now, let us check together that you have copied the code correctly." (Read your correct code in the following manner: 'zero five, zero one eight').

"Place a check mark in the box to show your answers to the next three questions.

- '2. Are you a boy or girl?'
- '3. How old are you today?'
- '4. When were you born' ...in the Month of....'
- 'Question 5 - the Day or Date when you were born''
(be sure no one writes in 'Tuesday'!)

7. The instructions in the shaded area of the Background page should be read aloud, including the reminder to erase not wanted marks. Have the pupils look at the example and follow as you read the question to them. After they have marked their answers say: "Be careful to mark only one answer space for every question, and if you have no idea of the correct answer, check the box opposite "I don't know".

The Background Information should have been completed within about 5 minutes.

8. Instruct the pupils to turn to Page 3 and to listen attentively, while following in their test booklets, as you read the first question to them.

Allow them time to consider the responses and to place a check mark in the answer box of their choice, then say:

"Now look at Question 2"

and continue as above to the end of Part One, Page 15. After completing Item 36, stop the test, and have pupils close their booklets.

9. Some method of identification will be required to ensure that each pupil receives his own test upon resumption of the administration. When the second sitting begins, have pupils turn immediately to Page 16, Item 37 and conduct Part Two in the same manner as Part One.

Allow approximately 35 minutes for completion of the test.

10. As soon as the test is finished have the students hand in their booklets. Bundle the written tests together and return them to the Principal's office, with the attached form. At the same time bundle ALL the unused tests separately and return them also to the Principal's office.

Detach here

11. Please complete this form and place it on top of the USED tests.

School Code Number _____
Number of Written Booklets
returned from this class _____
Number of Unused Booklets
returned from this class _____

Your participation and co-operation are appreciated. If you have any comments or suggestions about the assessment, we would be pleased to hear from you.

Bob Aitken, Consultant
Learning Assessment Branch
Ministry of Education
Parliament Buildings
Victoria, B. C.
V8V 1X4

APPENDIX C

THE ATTITUDE INSTRUMENT

Please write the Code Number for
your school in the boxes below

	-					
--	---	--	--	--	--	--

Student
Attitudes and Interests
In Science

BRITISH COLUMBIA SCIENCE ASSESSMENT

APRIL 1978

INTRODUCTION

This booklet is a serious attempt to find out what you, as a student, think about science and about learning science. Your answers will help improve science in the schools. Your answers will be useful only if you are as honest and accurate as you can be.

There are 6 different sections in your booklet. Each section begins with a set of directions. Read these carefully before you begin to answer. There are no right or wrong answers to these questions. Work quickly, but make sure you complete all questions. Usually your first impression is the best one.

Your help in completing this booklet to the best of your ability is greatly appreciated.

BACKGROUND INFORMATION

Answer these questions first:

1. Are you male or female? male ☐ 1
female ☐ 2

(10)

(11)

2. What grade are you in now? Grade 7 ☐ 1
Grade 8 ☐ 2
Grade 9 ☐ 3
Grade 10 ☐ 4
Grade 11 ☐ 5
Grade 12 ☐ 6

(12)

3. Which of the following have you taken?
(More than one answer is possible.)

- A) Science in Grade 7 ☐ 1
B) Science 8 ☐ 1
C) Science 9 ☐ 1
D) Science 10 ☐ 1
E) Biology 11 ☐ 1
F) Biology 12 ☐ 1
G) Chemistry 11 ☐ 1
H) Chemistry 12 ☐ 1
I) Physics 11 ☐ 1
J) Physics 12 ☐ 1
K) Other Senior Science ☐ 1

(13)

(14)

(15)

(16)

(17)

(18)

(19)

(20)

(21)

(22)

(23)

4. Which courses are you taking now?
(More than one answer is possible.)

- A) Science in Grade 7 ☐ 1
B) Science 8 ☐ 1
C) Science 9 ☐ 1
D) Science 10 ☐ 1
E) Biology 11 ☐ 1
F) Biology 12 ☐ 1
G) Chemistry 11 ☐ 1
H) Chemistry 12 ☐ 1
I) Physics 11 ☐ 1
J) Physics 12 ☐ 1
K) Other Senior Science ☐ 1

(24)

(25)

(26)

(27)

(28)

(29)

(30)

(31)

(32)

(33)

(34)

Part A

On the next few pages you will be given something printed in a box like this:

Sports

Describe how you feel about what is in the box by marking the scales below it.

Here is an example of a scale:

good : : : : : : : bad
 A B C D E F G

Meaning of the spaces on the scale:

- A = very closely connected with "good"
- B = closely connected with "good"
- C = slightly connected with "good"
- D = equally connected with both "good" and "bad"
- E = slightly connected with "bad"
- F = closely connected with "bad"
- G = very closely connected with "bad"

For example, if you feel that what is in the box is closely connected with "bad", you would check F on the scale like this:

good : : : : : ✓ : bad
 A B C D E F G

IMPORTANT

- Work quickly.
- Check each scale only once.
- Do not spend more than a few seconds on each scale.
- Do not go back to change any checks.
- Do not think about how you checked something else.
- Work quickly.

Go to the Next Page

Here is a sample for you to fill in for practice.

Sports

good	_____	_____	_____	_____	_____	_____	_____	bad
	A	B	C	D	E	F	G	
harmful	_____	_____	_____	_____	_____	_____	_____	beneficial
	A	B	C	D	E	F	G	
clean	_____	_____	_____	_____	_____	_____	_____	dirty
	A	B	C	D	E	F	G	
sick	_____	_____	_____	_____	_____	_____	_____	healthy
	A	B	C	D	E	F	G	
wise	_____	_____	_____	_____	_____	_____	_____	foolish
	A	B	C	D	E	F	G	

Now please go ahead with question 1.

1.

Scientists

good	_____	_____	_____	_____	_____	_____	_____	bad
	A	B	C	D	E	F	G	
harmful	_____	_____	_____	_____	_____	_____	_____	beneficial
	A	B	C	D	E	F	G	
clean	_____	_____	_____	_____	_____	_____	_____	dirty
	A	B	C	D	E	F	G	
sick	_____	_____	_____	_____	_____	_____	_____	healthy
	A	B	C	D	E	F	G	
wise	_____	_____	_____	_____	_____	_____	_____	foolish
	A	B	C	D	E	F	G	

Mean = 5.56
S.D. = 0.98

2.

Science

good	_____	_____	_____	_____	_____	_____	_____	bad
	A	B	C	D	E	F	G	
harmful	_____	_____	_____	_____	_____	_____	_____	beneficial
	A	B	C	D	E	F	G	
clean	_____	_____	_____	_____	_____	_____	_____	dirty
	A	B	C	D	E	F	G	
sick	_____	_____	_____	_____	_____	_____	_____	healthy
	A	B	C	D	E	F	G	
wise	_____	_____	_____	_____	_____	_____	_____	foolish
	A	B	C	D	E	F	G	

Mean = 5.41
S.D. = 1.04

3.

Doing Science Experiments

good	_____	_____	_____	_____	_____	_____	_____	bad
	A	B	C	D	E	F	G	
harmful	_____	_____	_____	_____	_____	_____	_____	beneficial
	A	B	C	D	E	F	G	
clean	_____	_____	_____	_____	_____	_____	_____	dirty
	A	B	C	D	E	F	G	
sick	_____	_____	_____	_____	_____	_____	_____	healthy
	A	B	C	D	E	F	G	
wise	_____	_____	_____	_____	_____	_____	_____	foolish
	A	B	C	D	E	F	G	

Mean = 5.23
S.D. = 1.03

Go To The Next Page

4.

Science I Have Taken in School

good	_____	_____	_____	_____	_____	_____	_____	bad
	A	B	C	D	E	F	G	
harmful	_____	_____	_____	_____	_____	_____	_____	beneficial
	A	B	C	D	E	F	G	
clean	_____	_____	_____	_____	_____	_____	_____	dirty
	A	B	C	D	E	F	G	
sick	_____	_____	_____	_____	_____	_____	_____	healthy
	A	B	C	D	E	F	G	
wise	_____	_____	_____	_____	_____	_____	_____	foolish
	A	B	C	D	E	F	G	

Mean = 5.26
S.D. = 1.13

5.

Industrialist

good	_____	_____	_____	_____	_____	_____	_____	bad
	A	B	C	D	E	F	G	
harmful	_____	_____	_____	_____	_____	_____	_____	beneficial
	A	B	C	D	E	F	G	
clean	_____	_____	_____	_____	_____	_____	_____	dirty
	A	B	C	D	E	F	G	
sick	_____	_____	_____	_____	_____	_____	_____	healthy
	A	B	C	D	E	F	G	
wise	_____	_____	_____	_____	_____	_____	_____	foolish
	A	B	C	D	E	F	G	

Mean = 4.72
S.D. = 1.16

6.

Reading Science Books

(50)	good	_____	_____	_____	_____	_____	_____	bad	(60)
		A	B	C	D	E	F	G	
(51)	harmful	_____	_____	_____	_____	_____	_____	beneficial	(61)
		A	B	C	D	E	F	G	
(52)	clean	_____	_____	_____	_____	_____	_____	dirty	(62)
		A	B	C	D	E	F	G	
(53)	sick	_____	_____	_____	_____	_____	_____	healthy	(63)
		A	B	C	D	E	F	G	
(54)	wise	_____	_____	_____	_____	_____	_____	foolish	(64)
		A	B	C	D	E	F	G	

Mean = 5.32
S.D. = 1.29

7.

School

(55)	good	_____	_____	_____	_____	_____	_____	bad	(65)
		A	B	C	D	E	F	G	
(56)	harmful	_____	_____	_____	_____	_____	_____	beneficial	(66)
		A	B	C	D	E	F	G	
(57)	clean	_____	_____	_____	_____	_____	_____	dirty	(67)
		A	B	C	D	E	F	G	
(58)	sick	_____	_____	_____	_____	_____	_____	healthy	(68)
		A	B	C	D	E	F	G	
(59)	wise	_____	_____	_____	_____	_____	_____	foolish	(69)
		A	B	C	D	E	F	G	

Mean = 5.69
S.D. = 1.31

Go To The Next Page

Part B

Directions for Items #8 - 17:

Below is a list of science and science related activities.
Rate these on a scale from 1 to 5 by circling the appropriate
number beside each item as follows:

SCALE:	1	2	3	4	5
	Definitely not willing to try this activity	Probably not willing to try this activity	Cannot decide one way or the other	Probably willing to try this activity	Definitely willing to try this activity

Example: a. Write a science fiction story . . . 1 ② 3 4 5

The circle around "2" shows that you would probably not be willing to try writing a science fiction story.

Circle a number beside each stated activity to indicate how willing you would be to try it on the basis of your interest.

You are to assume that there would be nothing to keep you from trying these activities except your own interest in science.

		Mean	S.D.							
8.	Go to a movie having to do with science	3.5	1.1	1	2	3	4	5		(70)
9.	Enter a science fair	3.0	1.3	1	2	3	4	5		(71)
10.	Watch a science show on T.V.	3.6	1.2	1	2	3	4	5		(72)
11.	Do extra science experiments at home	2.6	1.3	1	2	3	4	5		(73)

	SCALE:	1	2	3	4	5	
		Definitely not willing to try this activity	Probably not willing to try this activity	Cannot decide one way or the other	Probably willing to try this activity	Definitely willing to try this activity	
				Mean	S.D.		
12.	Take up a hobby having to do with science			3.1	1.2	1 2 3 4 5	(74)
13.	Read articles about science in a newspaper or magazine			3.3	1.2	1 2 3 4 5	(75)
14.	Find out how much I know in science compared to other students of my age in B.C.			3.0	1.0	1 2 3 4 5	(76)
15.	Take a test to find out whether I am suited to become a scientist			2.9	1.5	1 2 3 4 5	(77)
16.	Buy a book about science			2.6	1.3	1 2 3 4 5	(78)
17.	Take more science in school			2.8	1.4	1 2 3 4 5	(79)

Part C

Directions for items #18 - 29:

How often have you done the things mentioned below, voluntarily, just because you wanted to, during the PRESENT SCHOOL YEAR? Do this by circling the appropriate number for each item. The scale is labelled as follows:

SCALE:	1	2	3	4	5
	Never	Rarely (once or twice)	A few times	Quite frequently	Very frequently

Example: a. Watched a T.V. show about science . . . 1 2 3 4 5

The circle around "3" shows that you watched a T.V. show about science voluntarily a few times this year, because you were interested in doing so.

	Mean	S.D.	
18. Applied scientific information to situations outside of school	2.3	1.1	(80)
19. Listened to someone talk about science because I wanted to	2.6	1.1	(81)
20. Thought about problems such as how the earth, the stars, or life came to be	3.7	1.2	(82)
21. Tried to find out how mechanical things around the house work	1.3	1.3	(83)

SCALE:	1	2	3	4	5
	Never	Rarely (once or twice)	A few times	Quite frequently	Very frequently

	Mean	S.D.	
22. Talked to someone in school about things that interest me in science	2.5	1.1	(84)
23. Tried to find out how some of the major industries in B.C. such as fishing, lumbering, and mining, apply scientific ideas	2.0	1.1	(85)
24. Successfully carried out a scientific experiment which I designed myself	1.7	1.0	(86)
25. Carried out an experiment from a set of instructions because I wanted to	2.2	1.2	(87)
26. Copied science notes from the blackboard or overhead projector because I wanted to	2.7	1.4	(88)
27. Talked to someone outside of school about things that interest me in science	2.4	1.2	(89)
28. Memorized scientific information because I wanted to	2.4	1.3	(90)
29. Read from a textbook in science because I wanted to	2.4	1.2	(91)

Go On To The Next Page

Part D

Directions for items #30 - 42:

Indicate how strongly you agree or disagree with each of the statements that follow. Circle the appropriate number for each statement. The scale is as follows:

SCALE:	1	2	3	4	5
	Strongly disagree	Disagree	Undecided	Agree	Strongly agree

Example: a. A career in science would be boring . . . (1) 2 3 4 5

The circle around "1" shows that you strongly disagree that a career in science would be boring to you.

	Mean	S.D.	
30. Going into science as a career would be well worth the time and effort required	3.2	1.1	(10)
31. A career in science would be ideally suited to girls	3.1	1.1	(11)
32. A career in science connected with industry would be very satisfying to me	2.6	1.1	(12)
33. Science as a career would not interest me because the work does not deal with the social problems of our society	3.4	1.2	(13)
34. A career in science connected with government would be very satisfying to me	2.6	1.9	(14)

SCALE:	1	2	3	4	5
	Strongly disagree	Disagree	Undecided	Agree	Strongly agree

	Mean	S.D.	
35. A career in science would be ideally suited to boys	3.4	1.1	(16)
36. Science as a career would interest me because the work is necessary for human survival	3.3	1.1	(17)
37. A career in science would be against my beliefs	4.0	1.1	(18)
38. A career as a science teacher would be very satisfying to me	2.3	1.1	(19)
39. I would NOT consider a scientific career because the pay is too low	3.9	1.0	(20)
40. Science as a career would NOT interest me because the work is too hard	3.7	1.1	(21)
41. A career in science at a university or college would be very satisfying to me	2.7	1.1	(22)
42. A career in science in which experiments are carried out on animals would NOT interest me	3.1	1.4	(23)

Go On To The Next Page

Part E

Directions for items #43 - 64:

Indicate how strongly you agree or disagree with each of the statements that follow. Circle the appropriate number for each statement. The scale is as follows:

SCALE:	1	2	3	4	5
	Strongly disagree	Disagree	Undecided	Agree	Strongly agree

Example: a. Scientists should get a lot more recognition from the public 1 2 3 4 5

The circle around "5" shows that you strongly agree with this statement.

	Mean	S.D.	
43. Scientists are usually odd compared with most people I know	3.4	1.2	(24)
44. Scientists usually don't go along with things ordinary people like to do	3.4	1.1	(25)
45. Scientists have the answers to most of the problems of our society	2.8	1.2	(26)
46. Scientists practice a kind of magic	3.8	1.1	(27)
47. Scientists put a high value on human life	3.6	1.0	(28)
48. Scientists are right when they say that the planets do NOT determine success and failure in our daily lives	3.3	1.1	(29)
49. Scientists should govern our country	1.9	0.9	(30)
50. Scientists have done more harm than good in this world	3.8	1.1	(31)
51. Scientists today know much more about the world than the scientists did a long time ago	4.3	1.0	(32)
52. Scientists are right when they say that human life comes from some simpler forms of life	3.3	1.1	(33)

SCALE:	1	2	3	4	5	
	Strongly disagree	Disagree	Undecided	Agree	Strongly agree	
						Mean S.D.
53. Scientific facts are usually true						3.6 0.9 (34)
54. Scientific ideas can usually be proven by experiment						3.9 0.8 (35)
55. Scientific ideas are usually too difficult to understand for most ordinary people						2.8 1.1 (36)
56. Most scientific ideas of long ago are out-of-date because they are wrong						3.4 1.0 (37)
57. Science is getting closer and closer to the truth						3.6 0.9 (38)
58. Most scientific findings have been a blow against common sense						3.3 0.9 (39)
59. Scientific progress and the progress of man go together						3.5 1.0 (40)
60. Learning science makes you more broadminded						3.4 1.0 (41)
61. All knowledge can be classified as either scientific knowledge or nonsense						2.4 1.1 (42)
62. Science is the only answer to problems facing the people of the world today						2.5 1.1 (43)
63. Scientific research should NOT get any of the taxpayers' money						3.6 1.1 (44)
64. In everyday life science is NOT as practical as common sense						3.2 1.0 (45)

Go On To The Next Page

Part F

This is the final part of this booklet.

Directions for items #65 - 112:

Part F asks you questions about the kinds of things you do in science classes. We want you to answer the questions with only one science course in mind. Please follow the instructions below carefully.

If you are in Grade 7 or Grade 9, check this box ☐ 1
and go straight to the next page.

If you have not taken or are not taking any science courses beyond Grade 10, check this box ☐ 2
and do not complete Part F.

If you have taken or are taking PHYSICS 11, check this box ☐ 3
and go straight to the next page, answering the questions in terms of your experiences in Physics 11.

If you have taken or are taking CHEMISTRY 11, but not Physics 11, check this box ☐ 4
and go straight on to the next page, answering the questions in terms of your experiences in Chemistry 11.

If you have taken or are taking BIOLOGY 11 but not Chemistry 11 or Physics 11, check this box ☐ 5
and go straight on to the next page, answering the questions in terms of your experiences in Biology 11.

If you have taken or are taking a science course beyond Grade 10 but NOT one mentioned above, check this box ☐ 6 (46)
and do not complete Part F.

How often are you usually required to do each of the following in science classes? Use this scale:

SCALE:	1	2	3	4	5	6	
	Never	Almost never (once or twice during a course)	Considerably less than half of the time	About half of the time	Considerably more than half of the time	Almost every class	
							Mean S.D.
65. Carry out experiments from a set of instructions				4.1	1.4	1 2 3 4 5 6	(47)
66. Make up your own experiments				1.8	1.0	1 2 3 4 5 6	(48)
67. Discuss the possible errors in an experiment that has been completed				3.4	1.5	1 2 3 4 5 6	(49)
68. Listen to the teacher talk for most of the lesson				4.0	1.4	1 2 3 4 5 6	(50)
69. Make a graph from data you get from an experiment				2.9	1.5	1 2 3 4 5 6	(51)
70. Apply information learned to new problem situations				3.2	1.5	1 2 3 4 5 6	(52)
71. Make guesses about the results of an experiment				3.2	1.5	1 2 3 4 5 6	(53)
72. Interpret or explain for yourself the results of an experiment				3.5	1.5	1 2 3 4 5 6	(54)

How often are you usually required to do each of the following in science classes? Use this scale:

SCALE:	1	2	3	4	5	6
	Never	Almost never (once or twice during a course)	Considerably less than half of the time	About half of the time	Considerably more than half of the time	Almost every class

Mean S.D.

73. Classify objects or events	3.0	1.3	1	2	3	4	5	6	(55)
74. Describe or report observations in your own words	3.9	1.5	1	2	3	4	5	6	(56)
75. Make measurements in experiments	3.9	1.5	1	2	3	4	5	6	(57)
76. Do a worksheet	3.5	1.5	1	2	3	4	5	6	(58)
77. Discuss results of an experiment with other students	3.6	1.5	1	2	3	4	5	6	(59)
78. Copy notes from the blackboard or overhead projector	4.3	1.4	1	2	3	4	5	6	(60)
79. Work on problems at the end of a section in a book	3.6	1.6	1	2	3	4	5	6	(61)
80. Memorize scientific information	3.6	1.5	1	2	3	4	5	6	(62)
81. Do investigations at home	2.1	1.2	1	2	3	4	5	6	(63)
82. Read from science textbooks	3.6	1.5	1	2	3	4	5	6	(64)

How often do the following typically occur in your science classes? Use this scale:

SCALE:	1	2	3	4	5	6
	Never	Almost never (almost or twice during a course)	Considerably less than half of the time	About half of the time	Considerably more than half of the time	Almost every class

Mean S.D.

83. Students are allowed to rewrite tests they have failed	1.9	1.4	1	2	3	4	5	6	(65)
84. Students are given extra help by the teacher	3.9	1.5	1	2	3	4	5	6	(66)
85. Guest speakers are invited to class	1.6	1.0	1	2	3	4	5	6	(67)
86. Films/videotapes are shown	3.0	1.3	1	2	3	4	5	6	(68)
87. Newspaper and magazine articles are discussed	2.1	1.2	1	2	3	4	5	6	(69)
88. Field trips are organized	1.7	1.1	1	2	3	4	5	6	(70)

WHETHER YOU HAVE TAKEN THESE COURSES OR NOT how difficult to YOU think they are? Use this scale:

SCALE:	1	2	3	4	5
	Very easy	Easy	Average	Difficult	Very difficult

			Mean	S.D.						
89. Science 7	.	.	2.2	0.9	1	2	3	4	5	
90. Science 8	.	.	2.7	0.9	1	2	3	4	5	
91. Science 9	.	.	3.0	1.0	1	2	3	4	5	
92. Science 10	.	.	3.3	1.0	1	2	3	4	5	
93. Physics 11	.	.	4.1	0.9	1	2	3	4	5	
94. Chemistry 11	.	.	4.0	0.9	1	2	3	4	5	
95. Biology 11	.	.	3.7	1.0	1	2	3	4	5	
96. Earth Science 11	.	.	3.6	1.0	1	2	3	4	5	

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How often are you assigned science homework in each of the following categories? Use this scale:

SCALE:	1	2	3	4	5	6
	Never	Almost never (once or twice during a course)	Considerably less than half of the time	About half of the time	Considerably more than half of the time	Almost every class

			Mean	S.D.						
(71)										
(72)	97. Problems at the end of a section	.	3.5	1.5	1	2	3	4	5	6 (79)
(73)	98. Lab/experiment write-ups	.	3.8	1.7	1	2	3	4	5	6 (80)
(74)	99. Do at home experiments	.	1.8	1.1	1	2	3	4	5	6 (81)
(75)	100. Reading	.	3.5	1.4	1	2	3	4	5	6 (82)
(76)	101. Preparing reports on topics in science	.	2.6	1.4	1	2	3	4	5	6 (83)
(77)	102. Projects	.	2.5	1.4	1	2	3	4	5	6 (84)
(78)	103. Preparing for tests	.	3.9	1.2	1	2	3	4	5	6 (85)
	104. Completing work unfinished in class	.	3.9	1.5	1	2	3	4	5	6 (86)

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How important are each of the following in causing students to do poorly in science? Use this scale:

SCALE:	1	2	3	4		
	No importance	Slightly important	Quite important	Extremely important		
					Mean	S.D.
105. Difficulty of texts		2.7	0.9	1 2 3 4	(87)	
106. Weakness in mathematics		2.7	0.9	1 2 3 4	(88)	
107. Difficulty in taking tests		3.0	0.9	1 2 3 4	(89)	
108. Quality of instruction		3.2	0.9	1 2 3 4	(90)	
109. Confusing instructions for experiments		2.9	0.9	1 2 3 4	(91)	
110. Lack of interest in science		3.2	1.0	1 2 3 4	(92)	
111. Weakness in writing ability		2.2	0.9	1 2 3 4	(93)	
112. Difficulty of science as a subject		3.0	0.9	1 2 3 4	(94)	

Thank you for taking the time
to answer these questions.

HAND IN THE P KLET AS DIRECTED BY THE TEACHER

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BRITISH COLUMBIA
SCIENCE ASSESSMENT
1978

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General Report
Volume 2

A REPORT TO
THE MINISTRY OF EDUCATION,
SCIENCE AND TECHNOLOGY

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BRITISH COLUMBIA SCIENCE ASSESSMENT

GENERAL REPORT

VOLUME II

(TEACHER SURVEY)

This report was prepared by
Gerald A. Sieben
and
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for submission to

The Ministry of Education,
Science and Technology

by

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January 1979

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We appreciate also the co-operation of the staff at Print Services, Publication Services Branch in producing the tests. Other people who provided valuable assistance were Florence Pieronek (U.B.C. reading specialist), Jir Gaskell, Linda Erickson and Marsha Boseman.

Throughout the project, Marg Francis of U.B.C. palyed a key role. This report was typed by Beth Buchanan of U.B.C.

We would like to pay tribute here to the memory of the late Klaus Lundin of Alpha Secondary School in Burnaby, who, as a member of the Management Committee, not only inspired us with his enthusiasm bu also guided us with his knowledge during the early stages of the assessment.

* Names of persons involved are listed in the Summary Report.

PREFACE

This report is the result of a team effort. In Volume I Ted Hobbs was mainly responsible for Chapters 1 and 5, the section on the design of the achievement tests in Chapter 3, and the description of the grade 12 achievement results in Chapter 4. Walter Boldt drafted Chapter 2, and the section describing the design of the attitude instrument in Chapter 3. Terry Quelch drafted the section on the results of the attitude survey in Chapter 4. Gaalen Erickson drafted the sections describing the sampling procedures in Chapter 3, and the results of the grades 4 and 8 achievement tests in Chapter 4. Gerry Sieben was responsible for Volume II which deals with the teacher survey. Ted Hobbs was responsible for the final draft of the report, and Olga Bowes prepared the material for printing.

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CHAPTER 1
INTRODUCTION

1.1 Terms of Reference of the Assessment

As described in Volume I of the General Report, the 1978 British Columbia Science Assessment was carried out under terms of reference specified by the Ministry of Education as part of the learning assessment program. The purposes of the assessment program are:

1. To monitor student learning over time.
2. To inform the public of the strengths and weaknesses of the public school system.
3. To provide the province and individual districts with information which can be used to maintain strengths and overcome identified weaknesses.
4. To assist curriculum developers at the provincial and local levels in the process of improving curriculum and developing suitable resource materials.
5. To provide directions for change in teacher education and professional development.
6. To provide information that can be used in the allocation of resources at provincial and district levels.
7. To provide directions for educational research.

The program is not concerned with the assessment of specific courses such as Physics 12 or Science 9, but is designed to cover a broad range of subject matter with a stress on those science skills that are needed to function effectively in society.

In particular, the terms of reference for the science assessment called for multiple-choice achievement tests to be given in each of grades four, eight, and twelve and for questionnaires to be given to teachers in order to generate "information about the teaching/learning process that may be required for future decision makers".

The tests and questionnaires were developed and the results analyzed by a group of university science educators and school science teachers under contract to the Ministry of Education, Science and Technology. The Contract Team received advice and assistance from a Management Committee consisting of ministry officials, teachers, a school trustee, and a university professor. Distribution and collection of the tests and questionnaires, scoring, and processing of data, were carried out by B.C. Research.

1.2 The Survey

To gauge what science teaching practices were occurring in the classrooms of British Columbia, and to elicit the opinions of teachers on a number of topics, the science Contract Team was instructed to prepare three teacher questionnaires. Probably the best way to determine teacher concerns and practices would be to visit a representative sample of classrooms and science teachers. However, this approach was felt to be impractical within the resources available for the assessment.

Accordingly, three comprehensive questionnaires were developed: one for elementary school teachers, one for junior secondary science teachers, and one for senior secondary science teachers. These surveys were designed to document the views of practising teachers on a wide variety of topics. Questions were developed in order to collect data in the following categories:

- Teacher Background and General Information
- Leadership in Science Education
- Physical Facilities in Science Learning Areas
- Science Equipment and Materials
- Teacher Attitudes Towards the Teaching and Learning of Science
- Teacher Opinions on the Education of Science Teachers
- Instructional Practices
- Curriculum and Textbooks

Background information questions covered such areas as class levels taught, years of experience, type and recency of teacher education, age, and sex.

The questionnaires were designed to be self-administered, with responses consisting of checking or circling the appropriate answers. Strict confidentiality was maintained. The elementary level questionnaire was designed to be answered by elementary school teachers irrespective of the teaching assignment. The junior and senior secondary questionnaires were designed for full-time teachers who were teaching at least one science class in their present teaching load. During the development phase, the questionnaires were critically examined by science teachers at each level, and their suggestions for revisions to the questionnaires were generally acted upon. The three questionnaires are reproduced in full in Appendix A.

1.3 The Sample

The sampling procedures were such that the questionnaire responses can confidently be taken to provide a good representation of the opinions of teachers in the Province. The samples were selected by B.C. Research in the following way:

The samples of teachers were selected to receive one of the three questionnaires prepared, elementary, junior secondary, or senior secondary. The September 1977 Form J was used to determine which elementary grades and which secondary subjects were taught by each teacher. Nineteen categories were used to identify eligible teachers, these were: Kindergarten through grade 7 teachers (elementary sample = 8 categories), grade 8 through grade 10 science teachers (junior secondary sample = 3 categories), and the biology, chemistry, physics and earth science teachers at the grades 11 and 12 levels (senior secondary sample = 8 categories). Many teachers were thus considered in more than one category, but each teacher was randomly assigned to one of the categories for which he was qualified and was instructed to respond to the questionnaire as a teacher of that particular grade level or subject area.

The elementary teachers were randomly sorted into one of the grade categories for which each was qualified. A list of teachers was prepared in each grade category for each geographic region in the Province. The procedure to sample from each of these lists consisted of selecting, at random, a number between 1 and 5 to decide the first teacher, and thereafter, to select every 5th teacher to arrive at a twenty percent sample, proportional to the regions.

A random procedure was used to assign junior and senior secondary science teachers to one category of the available eleven. Once this assignment was completed, all teachers from each of the categories were surveyed. The category to which each teacher was assigned was marked on the front of the questionnaire, and the teachers were asked to respond as a teacher of "grade 9 Science" or "grade 11 Chemistry".

Table 1.1 shows the number of teachers to whom questionnaires were given and the number of questionnaires returned in each of the three samples.

TABLE 1.1

NUMBER OF TEACHERS SURVEYED AND QUESTIONNAIRES RETURNED

	Elementary	Junior Secondary	Senior Secondary
Teachers Sampled	2542	1090	510
Questionnaires Returned	2108	932	477
Return Rate	83%	275 ^{85%}	94%

Table 1.2 shows the percent of respondents in each of the three samples according to grade level or senior secondary science course.

TABLE 1.2

PERCENT OF EACH SAMPLE ASSIGNED TO EACH GRADE OR SUBJECT LEVEL

Elementary		Junior Secondary		Senior Secondary		
Grade Level	Percent of Sample	Grade Level	Percent of Sample	Subject and Level	Percent of Sample	
K	8	8	35	Biology	11	24
1	14	9	33		12	18
2	14	10	31	Chemistry	11	18
3	13				12	14
4	13			Physics	11	17
5	12				12	6
6	13			Earth	11	4
7	14			Science	12	

1.4 Data Treatment

Teacher responses were coded for computer processing. Data codification and data processing were conducted by B.C. Research.

The Statistical Package for the Social Sciences (S.P.S.S.), was used for processing the teacher responses. Univariate and bivariate contingency tables were generated as well as the data presented in Appendix A for each question.

As a general rule, differences between groups are mentioned in this report only if the difference exceeded the 0.05 level of significance when the chi-square for the particular contingency table was calculated. Differences between the responses of teachers at the elementary, junior and senior secondary levels were the only data not subjected to tests of significance. In all other cases, the differences mentioned in this report were significant at least to the 0.05 level of probability.

CHAPTER 2

TEACHER BACKGROUND AND GENERAL INFORMATION

Questions concerning teachers' age, sex, teaching experience and the nature and extent of post secondary education formed the introductory part of the questionnaires. These data constitute the basis of the discussion in this chapter.

2.1 The Nature and Extent of Teaching Experience

Table 2.1 shows the distribution of teachers according to years of teaching experience. More than one-third of the elementary and junior secondary teachers had taught for five years or less. Only 39 percent of the junior secondary teachers had taught ten years or more compared to 44 percent of the elementary school teachers and 63 percent of the senior secondary science teachers.

TABLE 2.1
PERCENT OF SCIENCE TEACHERS IN VARIOUS CATEGORIES BY YEARS OF
TEACHING EXPERIENCE AS OF JUNE 1978

Number of Years of Teaching Experience	Percent of Science Teachers		
	Elementary	Junior Secondary	Senior Secondary
1 or less	6	6	2
2 - 5	30	30	15
6 - 9	20	24	20
10 - 13	16	15	23
14 or more	28	24	40

In general, the senior secondary science teachers were the most experienced and the junior secondary science teachers were the least experienced teachers.

2.2 Age and Sex of Teachers

Table 2.2 shows how the age and sex of teachers at the three levels fall into clear-cut patterns.

TABLE 2.2
DISTRIBUTION OF SCIENCE TEACHERS IN EACH SAMPLE BY AGE AND SEX

Age and Sex of Science Teachers	Percent of Science Teachers		
	Elementary	Junior Secondary	Senior Secondary
Sex: Male	33	88	94
Female	66	12	6
Age: Under 30 yrs.	34	58	12
31 - 40 yrs.	36	33	48
Over 40 yrs.	30	9	40

The senior secondary teachers were the most senior group in terms of age, while the junior secondary teachers were the youngest, 58 percent being under 30 years old. The junior secondary teachers were also the least experienced of the three groups.

There was a disproportionately large number of females among the elementary teachers, with a reversal of this trend among the junior secondary teachers. Two-thirds of the elementary science teachers were females while at the junior secondary level 88 percent of the science teachers were males. By the time students reach senior secondary school they are being taught science by men almost exclusively. At the senior secondary level, 94 percent of the science teachers were males. In other aspects of the science assessment, large differences were observed between male and female secondary students in the achievement tests. Female students tended to do less well than male students on questions involving science content, and tended to avoid physical science courses in grades 11 and 12. The disproportionate number of male teachers at the secondary level could be a contributing factor to the differences found in student achievement and in student enrolment in courses such as physics and chemistry. Although many interconnected factors are probably involved in this situation, an investigation should be initiated to determine the effects, if any, of this great preponderance of males among secondary teachers.

2.3 Teachers' Post-Secondary Education

Once again an anomalous situation was found with respect to junior secondary science teachers. Thirteen percent of the junior secondary teachers reported that they had no courses in methods of teaching science. As indicated in Table 2.3 below, this percentage is much greater than is the case among the other two samples of teachers.

TABLE 2.3

PERCENT OF TEACHERS IN EACH SAMPLE WHO HAVE TAKEN
SCIENCE METHODS COURSES

Number of Science Methods Courses Taken	Percent of Teachers		
	Elemen- tary	Junior Secondary	Senior Secondary
None	8	13	6
One	64	35	37
Major	8	44	48
Other	11	9	9

2.3.1 Elementary Teachers' Science Education

Responses of the elementary teachers to background question VII are summarized in Table 2.4. This shows for each science specialty the percent of teachers who reported having taken 0, 1-3, 4-7, and 8 or more courses at college or university level.

TABLE 2.4

DISTRIBUTION OF ELEMENTARY TEACHERS ACCORDING TO NUMBER OF COURSES TAKEN IN VARIOUS SCIENCE SUBJECTS

Post-Secondary Science Courses by Subject	Percent of Elementary Teachers who Reported taking the following numbers of courses			
	0 Courses	1-3 Courses	4-7 Courses	8 or more Courses
Biology	39	54	5	3
Chemistry	58	38	3	1
Physics	68	29	2	1
Astronomy	88	11	0	0
Earth Science	59	35	3	2
General Science	32	64	3	1

The data from question VII were combined in order to classify elementary teachers' science background into four categories. The results were:

1. 11 percent reported having no science courses of any kind at university or college level.
2. 37 percent reported having one to three courses in at least one of the science subjects. This could be considered an adequate background for elementary school teachers.
3. 44 percent reported having one to three courses in at least two of the subjects. This could be considered to be a strong science background for elementary school teachers.
4. 8 percent reported having four to eight courses in at least one of the subjects. This can be considered to be a very strong background for elementary teachers.

Thus almost 90 percent of the elementary teachers reported having at least some university or college level science training.

2.3.2 Junior Secondary Teachers' Science Education

Responses of the junior secondary science teachers to background question VII are summarized in Table 2.5. This shows, for each science subject area, the percent of teachers who reported taking 0, 1-3, 4-7, and 8 or more courses at college or university level.

TABLE 2.5

DISTRIBUTION OF JUNIOR SECONDARY SCIENCE TEACHERS ACCORDING TO NUMBER OF COURSES TAKEN IN VARIOUS SCIENCE SUBJECTS

Post-Secondary Science Courses by Subject	Percent of Junior Secondary Teachers who Reported taking the following numbers of courses			
	0 Courses	1-3 Courses	4-7 Courses	8 or more Courses
Biology	14	31	23	32
Chemistry	5	55	27	13
Physics	14	60	17	9
Astronomy	81	18	1	0
Earth Science	39	50	5	6
General Science	49	45	4	2

The data from question VII were combined in order to classify the teachers' backgrounds into five categories. The results were:

1. 9 percent were categorized as having a very weak background. These respondents indicated having one to three courses in only one subject, or no science courses.
2. 8 percent were categorized as having a weak background. These respondents indicated having one to three courses in three or more subjects (but four or more in no subjects).
3. 6 percent were categorized as having a narrow background. These respondents indicated having four to seven courses in one subject, with one to three courses in no more than one other subject.
4. 15 percent were categorized as having a broad background. These respondents indicated having four to seven courses in one subject and one to three courses in at least two other subjects.
5. 59 percent were categorized as having a strong background. These respondents indicated having eight or more courses in at least one subject, or four to seven courses in at least two subjects.

Generally, the junior secondary teachers were well qualified as to science background, but the fact that seventeen percent have weak or very weak backgrounds gives cause for some concern. Many of these teachers may be qualified in other areas but found themselves filling gaps in the science timetable. Nonetheless, the fact that about one in six of the junior secondary teachers could be considered to be poorly qualified is less than a satisfactory situation, and warrants further investigation. Schools and school districts should, wherever possible, avoid assigning teachers to areas outside their expertise. Where this cannot be avoided, some provisions ought to be made for retraining in both methods and content. It is recommended that universities examine their course offerings to see that this type of teacher retraining is provided. It is also recommended that school districts supply appropriate incentive or release time for teachers to raise their level of competence in the subjects they are assigned to teach.

2.3.3 Senior Secondary Teachers' Science Education

Responses of the senior secondary teachers to background question VII are summarized in Table 2.6. This shows, for each subject area, the percent of teachers who reported taking 0, 1-3, 4-7, and 8 or more courses at college or university level.

TABLE 2.6

DISTRIBUTION OF SENIOR SECONDARY SCIENCE TEACHERS ACCORDING TO NUMBER OF COURSES TAKEN IN VARIOUS SCIENCE SUBJECTS

Post Secondary Science Courses by Subject	Percent of Senior Secondary Teachers who Reported taking the following numbers of courses			
	0 Courses	1-3 Courses	4-7 Courses	8 or more Courses
Biology	16	32	16	36
Chemistry	2	50	31	17
Physics	9	54	22	15
Astronomy	82	18	0	0
Earth Science	37	55	5	4
General Science	59	34	5	3

The data from question VII were combined in order to classify teachers' backgrounds into seven categories. The results were:

1. 54 percent were classified as specialists. These respondents reported having eight or more courses in one subject. Of these,
 - 29 percent were biology specialists,
 - 12 percent were chemistry specialists,
 - 12 percent were physics specialists, and
 - 2 percent were earth science specialists.

2. 6 percent were classified as multiple specialists. These respondents reported having eight or more courses in at least two subjects.
3. 9 percent were classified as generalists. These respondents reported having four to seven courses in at least two subjects, but more than seven in no subject.
4. 25 percent were classified as having an adequate background. These respondents reported having four to seven courses in only one subject and fewer than four in the other subjects.
5. 6 percent were classified as having a weak background. These respondents reported having more than three courses in no subject.

2.4 Nature of Science Teaching Assignments

2.4.1 Number of Science Courses Taught

Teacher responses to background question VIII are summarized in Table 2.7. This table reveals some interesting patterns. The elementary teachers appeared to be the least experienced of the three groups with respect to teaching in other parts of the school system.

One-half to three-quarters of the senior secondary teachers reported previous teaching experience at the junior secondary level, indicating a progression from junior secondary assignments to senior secondary teaching. Such a progression was less evident at the junior secondary level where only about twenty percent of the teachers reported having had elementary teaching experience. It may be that because elementary teachers are specially trained to teach at that level, they are more inclined to remain in that assignment. Secondary teachers, trained for both junior and senior secondary, apparently tend to progress towards the senior levels.

Surprisingly few secondary teachers reported teaching special electives. Similarly, few senior secondary teachers reported teaching Earth Science 11 (1%) or Geology 12 (2%).

TABLE 2.7
PERCENT OF TEACHERS WHO REPORTED TEACHING
SCIENCE AT VARIOUS LEVELS

Grade Level or Courses Taught	Percent of Teachers					
	Elementary		Junior Secondary		Senior Secondary	
	This Year	Previous Year	This Year	Previous Year	This Year	Previous Year
Elementary Science (Kindergarten, Primary)	48	50	0	3	0	3
Elementary Science (Intermediate)	49	54	2	17	0	13
Science 8	1	7	65	73	13	59
Science 9	1	4	68	69	20	63
Science 10	1	3	40	61	31	75
Biology 11	0	1	11	24	38	37
Biology 12	0	1	7	15	32	27
Chemistry 11	0	1	10	20	34	37
Chemistry 12	0	0	6	12	26	23
Physics 11	0	1	6	12	27	31
Physics 12	0	0	3	7	18	21
Earth Science 11	0	0	3	3	9	42
Geology 12	0	0	0	1	2	1
Special Electives	0	0	4	6	4	5

2.4.2 Time Allocation to Elementary School Science

Fewer than twenty percent of the elementary teachers specialized in science and taught science to more than one class. Seventy-nine percent of the teachers taught science to their own classes only. Table 2.8 shows the number of hours spent on science reported by those elementary teachers who indicated that they teach science to their own classes only. These data were obtained by cross-tabulating responses to questions 23 and 24 for each grade level.

TABLE 2.8

ESTIMATES OF TIME SPENT PER WEEK BY ELEMENTARY TEACHERS
IN TEACHING SCIENCE TO THEIR OWN CLASSES

Grade/Level Year	Suggested Time ¹ Minutes	Minutes Per Week Spent Teaching Science/ Percent of Elementary Teachers			
		30	60	120-180	240-300
Kindergarten		44	40	16	0
1	60-75 ²	18	60	21	0
2	65-75 ²	15	60	24	0
3	70-95 ²	6	65	28	1
4	70-80	4	52	43	1
5	70-80	2	53	45	1
6	80-100	3	42	54	1
7	160-200	0	21	73	6

¹ As set out in Administrative Guide for Elementary Schools, 1972.

² Includes science and social studies.

Generally, teachers appeared to be following the time guidelines for science fairly closely. Most teachers in elementary schools were devoting about an hour per week to science instruction. With the implementation of new programs it must be asked, however, whether this amount of time is sufficient to do justice to the programs and to provide children with enough science activity. The current time allotment suggests that science has been given rather low priority in the elementary grades.

2.4.3 Time Allocation to Secondary School Science

Secondary teachers were asked what type of timetable system was operating for science in their schools, and which type they would prefer. Responses are shown in Table 2.9.

TABLE 2.9

PERCENT OF JUNIOR AND SENIOR SECONDARY SCIENCE TEACHERS

Timetable System	Percent of Teachers			
	Junior Secondary		Senior Secondary	
	Current System	System Preferred	Current System	System Preferred
Quarter	11	10	3	3
Semester	38	35	57	33
Full Year	46	51	37	61
Other	5	4	3	3

The most common system at the junior secondary level was the regular full year system, whereas senior secondary teachers most commonly reported using the semester system. By far the most preferred system was the full year timetable. When the responses for the junior secondary grades were cross-tabulated, it was found that 75 percent of the teachers who were on the full year program preferred that system, whereas 59 percent of those who were using the semester system preferred the semester system.

The responses of senior secondary teachers to questions 39 (which timetable system does your school have), and 40 (which system would you prefer) were cross-tabulated as shown in Table 2.10. The full year system seems to be preferred by most senior secondary teachers, including over forty percent of those currently in a semester system.

TABLE 2.10

PREFERENCES AMONG TIME-TABLE SYSTEMS OF
SENIOR SECONDARY TEACHERS CURRENTLY USING VARIOUS SYSTEMS
(PERCENT OF TEACHERS)

		System Preferred by Percent of Teachers				
		Quarter	Semester	Full Year	Other	Total
System in Use	Quarter	<1	<1	1	0	2
	Semester	1	29	25	2	57
	Full Year	<1	3	33	<1	37
	Other	0	<1	2	1	3
	Total	3	33	61	3	

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Secondary teachers were asked "Do you have enough time to cover the science courses?" The responses are summarized in Table 2.5.3.3. Most of the teachers chose responses indicating that they felt there was insufficient time to teach their courses.

TABLE 2.11

RESPONSES TO "DO YOU HAVE ENOUGH TIME TO COVER THE SCIENCE COURSES?"

Response Choices	Percent of Teachers	
	Junior Secondary	Senior Secondary
More than enough time	3	1
Enough time	35	27
Almost enough time	26	33
Not enough time	37	39

Various cross tabulations indicated that:

1. Larger proportions of teachers of Physics 11 and Chemistry 12 indicated insufficient time than did teachers of other subjects.
2. Teachers who reported having large classes (see p. 24), indicated more frequently than did other teachers that they did not have enough time.
3. Also, a majority of the teachers who reported being on a semester system indicated insufficient time. Among the senior secondary teachers, 69 percent of those who indicated insufficient time also indicated being on the semester system. Among the junior secondary teachers, 72 percent of those who indicated insufficient time also said they were on the semester system. Table 2.12 shows the relationship between semestering and time problems in more detail.

TABLE 2.12

CROSS-TABULATION OF RESPONSES TO THE QUESTIONS "DO YOU HAVE ENOUGH TIME TO COVER THE SCIENCE COURSES?" AND "WHAT TIME-TABLE PATTERNS DOES YOUR SCHOOL HAVE?" (PERCENT OF TEACHERS)

Time Table System in Use	Senior Secondary ¹				Total
	More Than Enough Time	Enough Time	Almost Enough Time	Not Enough Time	
Quarter	0	2	<1	<1	3
Semester	<1	11	19	27	57
Full Year	<1	14	13	10	37
Other	<1	<1	<1	2	3
Total	1	27	33	39	

Time Table System in Use	Junior Secondary ²				Total
	More Than Enough Time	Enough Time	Almost Enough Time	Not Enough Time	
Quarter	<1	4	4	4	11
Semester	<1	10	10	17	38
Full Year	2	19	11	15	47
Other	0	2	1	2	5
Total	3	35	26	37	

¹ (Chi-square = 44.3 d.f. = 9, p<0.0001)

² (Chi-square = 27.6 d.f. = 9, p<0.001)

In the light of this apparent time problem, schools should investigate ways to vary their timetables to produce more time for science. Teachers might investigate their methods and the scope and sequence of their courses to make certain that they are using the time available in an efficient manner.

2.4.4 Deployment of Secondary Science Teachers' Time

As outlined in Table 2.13 on the next page, a greater percentage of senior secondary teachers than junior secondary teachers indicated they were full time science teachers.

Only a minority of junior secondary science teachers were not being asked to teach other subjects; slightly less than half were full-time science teachers. Twenty-five percent of junior secondary science teachers reported teaching part-time science with other non-math assignments as compared to 16 percent of senior secondary teachers.

TABLE 2.13

DEPLOYMENT OF SECONDARY SCIENCE TEACHERS' TIME

Type of Assignment	Percent of Science Teachers	
	Junior Secondary	Senior Secondary
Full-time science	46	59
Part-time science, part-time math	29	25
Part-time science, part-time in one other non-math subject area	12	6
Part-time science, part-time in two or more other subject areas	10	5
Part-time science, part-time counselling and/or administration	3	5

2.4.5 The Number of Students in Science Classes

Teachers were asked how many students were in their largest science classes (question VI). The responses to this question are summarized in Table 2.14.

TABLE 2.14

PERCENT OF ELEMENTARY, JUNIOR AND SENIOR SECONDARY TEACHERS BY SIZE
OF LARGEST SCIENCE CLASS

How many students are in your largest science class this year?	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
20 or less	14	4	15
21 - 24	25	8	27
25 - 28	33	25	34
29 - 32	22	51	21
Over 32	6	13	4

The table indicates that 64 percent of the junior secondary teachers reported their largest classes were over 29, including the 13 percent who reported unacceptably large classes of over 32 pupils. Generally, junior secondary laboratories can accommodate a maximum of thirty-two pupils. A serious problem may be indicated by these responses. In terms of safety and accident prevention, the question of culpability and liability should concern all of those involved in the decision to allow classes of this size. Many junior secondary labs and activities would be dangerous when conducted with such large groups. As indicated in the Science Summary Report Volume I, many problems seem to have been centered at the junior secondary level. These large classes may have been a contributing factor to the less than satisfactory student achievement at the end of grade 12 and to the apparently low morale of junior secondary teachers.

It is recommended that science classes at the junior secondary level be reduced, and classes over thirty strenuously avoided. At the junior secondary level, a maximum class size of 24 is proposed. Science laboratories should accommodate no more students than other "danger areas" such as the industrial education areas.

2.5 Summary

Senior secondary teachers were the oldest, most experienced and most qualified science teachers. Junior secondary teachers were the youngest, least experienced science teachers. All groups of teachers were generally quite well qualified, except that one in six of the junior secondary teachers was classified as having "weak" or "very weak" science background. Significant sex differences in staffing were noted: most elementary science teachers were women while nine out of ten secondary science teachers were men.

Elementary teachers taught science for only about one hour per week. Junior and senior secondary science teachers expressed concerns regarding the lack of time to cover their courses. There was a relationship between the lack of time and the semester system.

The largest science classes were at the junior secondary level.

2.6 Summary of Recommendations: Chapter 2

We recommend:

- 2.6.1 That school districts re-examine the wisdom of allowing the concentration of younger, less experienced teachers at the junior secondary grades, and that more experienced science teachers be placed at the junior secondary level.
- 2.6.2 That school districts recruit, over a period of years, in such a way as to obtain a better balance between the sexes of teachers.
- 2.6.3 That the Ministry of Education, Science and Technology increase the number of hours per week for science instruction in the elementary grades to allow the full potential of the new elementary program to be realized.
- 2.6.4 That school districts avoid assigning teachers who have little science background to science teaching in the junior secondary grades. Where teachers must be reassigned outside their specialty, provision should be made for retraining and universities could offer programs to allow for such retraining. School Districts could supply incentive and release time for teachers to improve their competence in the areas they are assigned to teach.
- 2.6.5 That secondary schools examine ways in which to obtain more time for science instruction. The semester system should be re-examined in terms of its ability to provide adequate time.
- 2.6.6 That teachers re-examine their use of instructional time in order to determine if they could make more efficient use of the time provided.
- 2.6.7 That large junior secondary classes be reduced to a safe, manageable size.

CHAPTER 3
LEADERSHIP IN SCIENCE EDUCATION

3.1 Leadership at the School Level

3.1.1 Types of School Leadership

Teachers were asked to describe the form of science leadership existing in their schools. As summarized in Table 3.1, secondary schools generally had a specially designated science coordinator or department head. In contrast, 60 percent of elementary teachers reported that there was no particular form of science leadership in their schools. Particularly during a time when a new curriculum has been introduced to the elementary school, this may present a serious problem.

TABLE 3.1
TYPES OF SCIENCE LEADERSHIP IN BRITISH COLUMBIA SCHOOLS

With reference to the elementary/ secondary science program in your SCHOOL: Which of the following best describes the form of leader- ship which exists?	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
There is a specially designated science coordinator or department head who is responsible for just the level in which the teacher teaches.	5	63	66
There is a specially designated science coordinator or department head who is responsible for elementary and secondary grades.	1	2	0
There is a specially designated coordinator or department head who is responsible for science and one or more other subjects.	1	10	14
Leadership and coordination are performed by a working group of teachers in the school.	12	13	10
Leadership and coordination have been assumed by the principal, vice-principal or one of the teachers.	17	3	1
There is no particular form of leadership.	60	8	7
Other.	3	2	2

3.1.2 Adequacy of Leadership Within the School

Teachers were asked to rate the adequacy of the leadership within the school. As shown in Table 3.2, a larger proportion of the elementary teachers than of the secondary teachers demonstrated concern regarding school leadership in science.

TABLE 3.2
ADEQUACY OF SCHOOL LEADERSHIP IN SCIENCE EDUCATION

In general terms, how do you rate this form of (school) leadership?	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
Very good or excellent ¹	16	51	55
Satisfactory	54	45	39
Unsatisfactory or very unsatisfactory ¹	31	8	7

¹ Five responses categories collapsed to three

About one-third of the elementary teachers indicated concern about the lack of science leadership. The elementary teachers most often indicated very good or excellent ratings of forms of leadership when a specially designated coordinator or department head for science was available.

In a later part of the questionnaire, elementary teachers indicated they felt their administrators tended to see science as equally or less important than other subjects. This finding may have a bearing on the leadership question with respect to science in the elementary schools.

The Contract Team recommends that schools without leadership in science should be encouraged to have a teacher designated as a science coordinator.

3.2 Leadership at the District Level

3.2.1 Forms of Leadership at the District Level

Table 3.3 shows the teachers' responses to the question of which form of leadership existed at their district level. The responses indicated a pervasive problem with respect to science leadership in districts, especially at the secondary level. More than half the secondary teachers indicated there was no form or leadership in their districts.

TABLE 3.3
FORMS OF LEADERSHIP IN SCIENCE AT THE SCHOOL DISTRICT LEVEL

With reference to the elementary/ secondary science program in your DISTRICT: Which of the following best describes the form of leader- ship which exists?	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
There is a specially designated science coordinator or supervisor responsible for just the grade levels in which the teacher teaches.	15	10	9
There is a specially designated science coordinator or supervisor who is responsible for elementary and secondary grades.	4	2	4
There is a specially designated coordinator or supervisor who is responsible for science and one or more other subjects.	13	7	10
Leadership and coordination are performed by a working group of teachers in the district.	19	17	16
Leadership and coordination have been assumed by one of the administrators or teachers in the district.	8	4	2
There is no particular form of leadership	38	57	56
Other	4	3	3

3.2.2 Adequacy of Leadership at the District Level

Over one-third of the elementary teachers and nearly half the secondary teachers reported that the form of district leadership in science was unsatisfactory, as shown in Table 3.4, page 32.

TABLE 3.4
ADEQUACY OF SCHOOL DISTRICT LEADERSHIP IN SCIENCE EDUCATION

In general terms, how do you rate this form of (district) leader- ship	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
Very good or excellent ¹	15	14	11
Satisfactory	51	41	44
Unsatisfactory or very unsatisfactory ¹	34	46	45

¹ Five categories of responses collapsed into three categories.

Of the 57 percent of junior secondary teachers who reported no particular form of leadership in their district, 68 percent rated the situation as unsatisfactory. A similar pattern was found among the senior secondary teachers.

It is recommended that this situation be addressed, and that districts consider the appointment of district science coordinators where none exist. These coordinators could pay special attention to the secondary grades, as the secondary teachers more often indicated an unsatisfactory situation. Such leadership and coordination at the district level would serve to counteract any suspicion and misunderstanding between feeder elementary and receiver secondary schools, and would also ensure that workable district policies for science education are in practice.

3.3 Summary of Recommendations: Chapter 3

We recommend:

- 3.3.1 That schools without leadership in science education, particularly elementary schools, designate a successful science teacher as the school's science coordinator where this is feasible.
- 3.3.2 That districts appoint a capable science teacher as a science coordinator for the district where this has not already been done.

CHAPTER 4

PHYSICAL FACILITIES IN SCIENCE LEARNING AREAS

4.1 Physical Facilities in Elementary Schools

Teachers were asked to rate the adequacy of various physical facilities for teaching science in their schools, using the following six point scale:

<u>Not Needed</u>	<u>Very Inadequate</u>				<u>Excellent</u>
0	1	2	3	4	5

Means were calculated, omitting the zeros circled on the scale. These means are shown in Table 4.1; a separate column shows the percent of teachers who indicated a facility that was not needed.

TABLE 4.1

RATINGS GIVEN BY ELEMENTARY TEACHERS TO THE PHYSICAL FACILITIES FOR TEACHING SCIENCE IN THEIR SCHOOLS

Facility	Facility Not needed	Teacher Ratings	
	Percent of Teachers	Mean	S.D.
a) Lighting	8	3.3	1.0
b) Storage space for science materials/equipment	1	2.3	1.1
c) Storage space for dangerous materials	28	2.3	1.2
d) Storage space for student projects	3	1.7	0.9
e) Science preparation room	26	1.6	1.0
f) A.V. equipment	2	3.4	1.1
g) Gas outlets	65	1.6	1.0
h) Water outlets	4	2.6	1.1
i) Electrical outlets	3	2.6	1.1
j) Sinks or drainage facilities	1	2.6	1.2
k) Flat-topped desks or tables	2	2.9	1.2
l) Safety equipment	27	2.4	1.0
m) Amount of work space per student	1	2.5	1.0

Many of the elementary teachers reported that they lacked necessary physical facilities in their classrooms. Storage for equipment, materials and student projects seemed to be a major concern. Elementary teachers also indicated that they lacked an adequate area for preparing science materials. The large number of teachers reporting inadequate storage facilities for dangerous materials requires immediate attention.

During the previous years when school enrolments were escalating and building programs could barely keep up with the demand, classrooms were constructed with few science facilities and for programs which did not require much in the way of electrical outlets, running water, etc. With the recent implementation of a new elementary science program which involves more pupil activity manipulating science equipment, more demands have been made on classroom facilities. During this time of declining enrolment, an excellent opportunity may exist for the upgrading of elementary school classrooms. For example, many classrooms (especially intermediate classrooms) lack running water and a sink. It is recommended that steps be taken to remedy this type of situation. Science preparation areas, complete with adequate central storage facilities, might be one good use for classrooms which become vacant due to enrolment declines. Another possible use of empty classrooms might be to join adjacent empty classrooms to form properly equipped science rooms. The problem of necessary classroom area should be re-examined and new standards of area-per-pupil established for any new construction.

4.1.2 Safety Equipment in Elementary Science Learning Areas

Fifty-nine percent of the elementary teachers indicated there was no safety equipment in their science learning area. Only one-quarter of the teachers reported any form of systematic check of their safety equipment. One-third of the elementary teachers indicated they felt that the supply of safety equipment in their classrooms was inadequate. With the advent of more laboratory-centered learning in the elementary grades, there must be necessary precautions in case of injury. The Contract Team therefore, recommends that the Ministry of Education, Science and Technology establish minimum standards for basic safety equipment in science learning areas.

4.2 Physical Facilities in Secondary Schools

Table 4.2 shows the junior secondary science teachers' ratings of the adequacy of physical facilities in their schools. Ratings of senior secondary teachers were similar and hence, are not reported here. The following six-point scale was used:

<u>Not Needed</u>	<u>Very Inadequate</u>				<u>Excellent</u>
0	1	2	3	4	5

In Table 4.2 the mean ratings were calculated on the basis of all respondents. Unlike elementary teachers, few secondary teachers used the "not needed" option in response to the facilities listed in this table.

TABLE 4.2

RATINGS GIVEN BY SECONDARY TEACHERS TO THE PHYSICAL FACILITIES FOR TEACHING SCIENCE IN THEIR SCHOOLS

Facility	Teacher Ratings	
	Mean	S.D.
a) Tables/counters	3.5	1.1
b) Lighting	4.0	0.9
c) Storage space for science materials/equipment	3.2	1.3
d) Amount of work space per student	3.1	1.1
e) Growing room/preparation room	2.8	1.4
f) Storage space for student projects	2.2	1.7
g) Audio-visual equipment	3.5	1.0
h) Storage space for acids	3.2	1.3
i) Storage space for volatiles	3.0	1.3
j) Gas outlets	3.6	1.2
k) Water outlets	3.4	1.2
l) Electrical outlets	3.7	1.1
m) Sinks or drainage facilities	3.5	1.2
n) Fume hood/closet	2.9	1.4
o) Safety equipment	3.1	1.1

Although their ratings of physical facilities were generally much higher than the elementary teachers', the secondary teachers expressed concerns about preparation areas, storage space for volatiles and acids, storage space for student projects, storage for equipment, fume closets and safety equipment.

More than half the secondary teachers indicated there were inadequate storage facilities for pupil projects. In another part of the survey, teachers reported that they seldom provide students with the opportunity to work on science projects. Perhaps this lack of proper storage is one reason.

More than one-quarter of the teachers indicated there were inadequate facilities for the storage of equipment and science materials. In general, storage facilities seemed to be widespread concerns.

More than one-third of the secondary science teachers indicated less than adequate situations regarding the storage of volatiles. More than one-quarter of the teachers also reported inadequate storage area for acids and dangerous substances. Proper metal cupboards, with locks, for volatiles, and proper acid rooms are required in each secondary school. It is recommended that district authorities and fire department professionals should determine where facilities fall short of basic safety standards and take the necessary corrective action.

More than one-third of junior secondary and one-quarter of senior secondary teachers reported inadequate fume closets in their laboratories. Again, because of the potential health hazard, district investigations should be conducted.

More than one-quarter of the junior secondary teachers indicated that safety equipment was inadequate. There should be no inadequacy of safety equipment in high school laboratories.

Table 4.3 shows teachers' indications of which types of safety equipment they had in their science teaching areas.

TABLE 4.3

PERCENT OF JUNIOR AND SENIOR SECONDARY SCIENCE TEACHERS REPORTING VARIOUS TYPES OF SAFETY EQUIPMENT IN THEIR SCIENCE TEACHING AREAS

Type of Safety Equipment	Percent of Teachers	
	Junior Secondary	Senior Secondary
None	1	3
Fire Blankets	54	44
Fire extinguisher	94	92
Master gas shut-off	88	86
Master shut-off	28	24
Approved first aid kit	52	61
Safety goggles	56	54
Asbestos gloves	17	19
Sand buckets and scoops	12	9
Eye wash stations	74	68

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In response to question 6 ("How systematically is the safety equipment checked in your science area/room/laboratory?"), 36 percent of the junior secondary and 31 percent of the senior secondary teachers responded "casually at best".

It is somewhat alarming that so many classrooms lack such basic safety equipment as first aid kits, safety goggles or fire extinguishers, and that the safety equipment is not checked systematically in about one-third of the science teaching areas.

We recommend that the Ministry of Education, Science and Technology establish minimum safety standards for school science areas, and provide funds for school districts to survey the present safety equipment and to remedy inadequacies. It is further recommended that district personnel ensure systematic annual checks of safety equipment are carried out in all science teaching areas.

4.3 Summary

Elementary school science classes are reported generally to have inadequate physical facilities. Lack of storage space for equipment and student projects were frequently reported. Physical facilities necessary for science such as running water and electrical outlets were rated inadequate by almost half the teachers. Nearly half the elementary teachers felt that their classrooms were too small for the numbers of students enrolled. Elementary teachers also indicated the need for science preparation rooms. Facilities in secondary school science rooms were, on the whole, satisfactory, but some problems were reported with respect to storage space for equipment and student projects, and with respect to inadequate preparation rooms.

Safety equipment was in general an area of concern at both the elementary and the secondary school levels.

4.4 Summary of Recommendations: Chapter 4

We recommend:

- 4.4.1 That school districts take steps to provide elementary classrooms, where science is taught, with sinks, electrical outlets, flattop tables or desks, storage space for equipment and student projects, and where space is available, to provide access to a science preparation room.
- 4.4.2 That the Ministry of Education, Science and Technology establish safety standards for school science classrooms, and provide funds for school districts to conduct surveys of the science safety equipment in schools where science is taught and to correct deficiencies that may be discovered through the surveys.
- 4.4.3 That district administrative personnel ensure that checks of safety equipment are conducted systematically in all science teaching areas.

CHAPTER 5

SCIENCE EQUIPMENT AND MATERIALS

5.1 Elementary School Science Equipment and Materials

5.1.1 Availability of Equipment

The elementary teachers were asked, "Apart from minor changes, how often have you had to adapt your teaching plans this year because of difficulty in obtaining the necessary science equipment?" (Question 7). The responses that were selected are as follows:

<u>Response choices:</u>	<u>Percent of Teachers</u>
Never	16
Seldom; about once or twice	40
Fairly often; about three or four times	20
Quite often; about five or six times	8
Far too often; more than six times	7
I seldom plan to use equipment	10

Approximately one-third of the elementary teachers had to adapt their teaching plans often (at least three times) during the year because of equipment problems. In response to question 12, "How difficult is it to obtain science equipment when you need it?" 42 percent responded "somewhat difficult" or "very difficult". When the responses for question 12 were examined separately for the groups who reported using each of the three program options, the following patterns emerged: Teachers using STEM most often reported difficulty obtaining equipment. Teachers using Exploring Science most often reported seldom using equipment. Teachers using Materials Based Program least often reported difficulty obtaining equipment.

Since nearly half the elementary teachers reported experiencing equipment difficulties with the new programs, it is recommended that those involved in implementing the programs ensure the necessary equipment and materials are provided. New programs may fail to achieve their desired goals if the necessary accompanying equipment is not readily available to teachers and pupils. Top priority should be given to providing this equipment promptly to avoid teachers developing a lasting impression that science is an 'especially' difficult subject to teach.

5.1.2 Quality of Equipment

Forty percent of the elementary teachers responded that the quality of science equipment available is good or excellent. (Question 8) Bivariate comparisons revealed that teachers using the Materials Based Program or a combination of programs were most inclined to rate their equipment as good or excellent. Forty-two percent of the teachers rated the equipment as tolerable and 18 percent rated the equipment as poor. Those teachers with more negative appraisal of the equipment quality tended to be using the Exploring Science and STEM programs.

5.1.3 Teacher Input into the Purchase of Equipment and Materials

Most teachers (66 percent) felt that they had enough input into deciding on the science equipment and materials to be purchased.

5.1.4 Maintenance of and Accounting for Elementary Science Equipment

The new elementary science program often involves hundreds of common household articles and simple equipment. These materials, particularly when in kit form, have been known to become disorganized and scattered about very quickly. Teachers were asked, "Who maintains and accounts for the science equipment in your school?" The following responses were selected:

<u>Response choices:</u>	<u>Percent of Teachers</u>
Each science teacher looks after his/her own equipment . . .	38
Each science teacher looks after certain equipment	5
A specially designated science teacher	36
Head of science department	3
Paid assistants	3
Nobody takes any responsibility	13
Other	2

In summary, equipment was generally handled at the teacher level, either by regular classroom teachers or by a specially designated science teacher. Teachers were also asked what form of assistance they were given for cleaning up after lessons, for preparing new lessons and for maintaining science equipment. Only 11 percent indicated that no assistance was required. About half the teachers indicated that they received no assistance whatsoever, and about one-third relied on volunteer student assistance. Teachers who taught more than one science class relied more heavily upon volunteer student help than did the teachers who taught science to only their own classes.

5.1.5 Distribution of Equipment to Elementary Classrooms

Teachers were asked how difficult it was to obtain necessary equipment, and where the equipment was stored in the school. Responses to these two questions were cross-tabulated as shown in Table 5.1. Forty-two percent of the elementary teachers reported some difficulty in obtaining equipment.

TABLE 5.1

CROSS-TABULATION OF ELEMENTARY TEACHERS' RESPONSES TO QUESTION 12
(HOW DIFFICULT IS IT TO OBTAIN SCIENCE EQUIPMENT WHEN YOU NEED IT?)
AND QUESTION 13 (WHERE IS MOST OF THE EQUIPMENT STORED IN YOUR
SCHOOL?) (PERCENT OF ELEMENTARY TEACHERS)

Responses to Question 13: (Where equipment is stored)	Very Difficult	Somewhat Difficult	Not Very Difficult	Not Difficult At All	Total
Convenient central storage room	<1	10	20	7	37
Inconvenient central storage room	1	10	9	2	22
Scattered throughout the school	3	13	10	2	28
Designated classrooms	<1	3	6	1	10
Other	<1	2	2	<1	5
Total	5	37	46	13	

(Chi square = 180, d.f. = 12, $p < .0001$)

The table indicates that the most satisfactory method of storage, from the teachers' point of view, was the central storage room. It is recommended that such a system be established in each school where one is not now available.

Question 11 asked teachers to indicate by which methods they usually obtained their science equipment. Most teachers obtained their equipment through a central source within the school (57 per cent). Nearly half the teachers also obtained equipment through a central source in the district. Surprisingly, 39 percent of elementary science teachers also reported that they obtained their own equipment.

5.1.6 Science Equipment and Materials Kept in the Classroom

Modern elementary science programs such as those recently adopted in British Columbia stress the necessity for pupil activity which involves children interacting with safe, selected "real world objects". Question 52 asked teachers which items they kept in their classrooms throughout the school year, and question 53 asked which items they had in their classroom at some time during the year. Responses are shown in Table 5.2 on the following page.

TABLE 5.2

PERCENT OF TEACHERS WHO REPORTED HAVING VARIOUS ITEMS OF SCIENCE EQUIPMENT IN THEIR ROOMS DURING SCHOOL YEAR

Which of the following do you keep in your classroom?	Percent of Teacher Responses	
	Part of Year	Throughout Year
Live animals	54	24
Fish	24	20
Thermometers	67	55
Globe	72	64
Batteries	34	16
Equal arm or pegboard balances	40	29
Spring scales	38	18
Hand lenses	59	36
Magnets	59	37
Magnetic compasses	36	13
Plasticene	61	60
Flashlights	41	9
Mirrors	47	28
Balloons	53	25
Plants	70	62
Seeds	62	33
Candles	45	23
Rocks	60	38
Barometer	16	9
Alcohol burners	14	7
Hot plate	30	12
Clock with second hand	58	54

Large numbers of teachers reported that they never had any of the following materials available for any portion of the year: heat sources such as candles, alcohol burners or hot plates, seeds, flashlights, compasses, equal arm or pegboard balances, spring scales, or batteries, or living things such as fish. The Contract Team is of the opinion that these simple, basic materials, where it is currently not the case, should be readily available for pupil and teacher use.

5.2 Junior and Senior Secondary Equipment and Materials

5.2.1 Availability of Necessary Equipment

Unlike the elementary school teachers, few secondary teachers expressed major concerns regarding equipment and materials. Sixty-nine percent of the junior secondary teachers and 78 percent of the senior secondary teachers reported that they never or seldom had to adapt their teaching plans during the year because of difficulty in obtaining the necessary science equipment. (Question 8). In response to question 12, which asked how difficult it was to obtain the necessary science equipment, 77 percent of the junior secondary teachers and 64 percent of the senior secondary science teachers reported that

they had little or no difficulty. Generally, the availability of equipment does not appear to be a concern in secondary schools.

5.2.2 Quality of Secondary Science Equipment

Overall, 74 percent of the junior secondary teachers and 80 percent of the senior secondary teachers rated their science equipment as good or excellent.

5.2.3 Secondary Teacher Input into the Purchase of Equipment

Eighty-seven percent of the junior secondary teachers and 89 percent of the senior secondary teachers felt that their input into the purchasing process was satisfactory.

5.2.4 Maintenance of the Accounting for Secondary Science Equipment

Equipment and materials were looked after in a number of ways. Most commonly at the senior level, each teacher tended to look after his own materials. At the junior secondary level, teachers tended to rely upon the department head. Responses to question 11 "Who maintains and accounts for the science equipment in your school?" are summarized in Table 5.3.

TABLE 5.3

PERCENT RESPONSES BY JUNIOR AND SENIOR SECONDARY SCIENCE TEACHERS TO QUESTION 11: "WHO MAINTAINS AND ACCOUNTS FOR THE SCIENCE EQUIPMENT IN YOUR SCHOOL?"

Equipment maintenance and accounting	Percent of Teachers	
	Junior	Senior
Each science teacher looks after his/her own equipment	23	42
Each science teacher looks after certain equipment	10	13
A specially designated science teacher	9	4
Head of science department	37	20
Paid assistants	15	16
Nobody takes any responsibility	2	1
Other	1	4

5.2.5 Funding Allocations for Secondary Science Programs

Secondary teachers responded that in general there was enough money allocated to the support of the science program in their schools. Seventy-three percent of the junior secondary and 77 percent of the senior secondary felt that funding was satisfactory.

5.3 Supplementary Reading Materials

- 5.3.1 Teachers were asked to indicate the number of different titles of science magazines and books (other than prescribed texts) which were available in their science room or laboratory. Responses are given in Table 5.4. Disappointingly few supplementary reading materials seem to be available to most students.

TABLE 5.4

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS CHOOSING EACH OPTION IN RESPONSE TO THE QUESTION "HOW MANY DIFFERENT TITLES OF SCIENCE MAGAZINES OR BOOKS (NOT TEXT BOOKS) ARE USUALLY AVAILABLE TO YOUR STUDENTS IN YOUR SCIENCE AREA/ROOM/LABORATORY?"

Number of Titles	Percent of Teachers		
	Elementary	Junior	Senior
None	32	32	29
1 - 5	48	56	51
6 - 10	9	5	9
11 - 15	2	2	3
More than 15	9	4	9

At all levels, science learning areas generally seem to be "bookless" areas. In order to foster more reading in science, supplementary reading materials and attractive science reading centres should be readily available. It is recommended that corrective action be taken by science teachers. Science rooms could accommodate book and magazine racks. Titles could be obtained on loan from the school libraries. Sets of selected books could be brought into science learning areas and these sets could be changed as students and teachers move from one topic of study to another. Science supply companies and book-stores often have sets of attractive science paperbacks available. A wise investment for school science departments may be the purchase of sets of supplementary reading materials, especially current science magazines.

5.3.2 Science Reading Materials in School Libraries

As shown in Table 5.5, the vast majority of science teachers at all levels indicated that their school libraries held adequate science reading materials. About one-quarter of the teachers indicated that deficiencies existed. Likely these deficiencies could be solved in many cases simply by surveying the science titles available and by presenting a list of recommended titles to the school librarian.

TABLE 5.5

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS CHOOSING EACH OPTION IN RESPONSE TO THE QUESTION "IN YOUR OPINION HOW ADEQUATE ARE THE SCIENCE READING MATERIALS IN YOUR SCHOOL LIBRARY?"

Adequacy of Science Materials in Library	Percent of Teachers		
	Elementary	Junior	Senior
Very inadequate	7	5	5
Somewhat inadequate	21	19	19
Satisfactory	53	50	46
Very adequate	19	25	31
There is no school library	5	0	0

5.4 Summary

Most concerns about equipment and materials were indicated by elementary teachers. Almost half the elementary teachers did not have the necessary equipment. Elementary teachers had problems with the distribution and maintenance of these materials. Many elementary school children did not have basic, simple science materials available to them. Few equipment problems were reported in the secondary grades. At all levels insufficient supplementary reading materials in the science learning areas were reported.

5.5 Summary of Recommendations: Chapter 5

We recommend:

- 5.5.1 That the Ministry of Education, Science and Technology consider ways to ensure that schools using the new elementary science programs have sufficient supplies of the necessary science equipment. A method of supply could be designed so that it is systematic and thorough.
- 5.5.2 That school districts establish a system whereby elementary teachers receive assistance with the acquisition, handling and maintenance of equipment.
- 5.5.3 That school districts establish a central storage and distribution system for elementary science materials along with easy teacher access to the equipment. Accessible central storage is necessary within the school as well.
- 5.5.4 That districts supply a set of basic, simple science materials to each elementary classroom. This basic, simple equipment could be available to the children and their teachers throughout the year.
- 5.5.5 That teachers and administrators see to it that supplementary science reading materials are available to students in all science learning areas.

CHAPTER 6

TEACHER ATTITUDES TOWARDS THE TEACHING AND LEARNING
OF SCIENCE

6.1 Teachers' Opinions as to the Worth of the Science Curriculum

Teachers were asked "In your opinion, how worthwhile is the prescribed B.C. Science program to the students you are presently teaching?" Responses are shown in Table 6.1.

TABLE 6.1

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "IN YOUR OPINION, HOW WORTHWHILE IS THE PRESCRIBED B.C. SCIENCE PROGRAM TO THE STUDENTS YOU ARE PRESENTLY TEACHING?"

Response choices	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
Very Worthwhile	21	22	43
Of some worth	64	65	55
Of little worth	11	11	3
Practically worthless	4	3	0

At the elementary level, a new curriculum is being implemented so probably responses to this question were elicited prematurely. Indeed, many written comments by teachers attested that it was too early to evaluate the program.

Responses of elementary and junior secondary teachers were very similar. Only about one in five of the teachers were prepared to rate the curriculum as "very worthwhile". About two-thirds of the elementary and junior secondary teachers rated the curriculum as being "of some worth". Senior secondary teachers were the most supportive of their curriculum.

6.2 Importance of Science in the Curriculum

Table 6.2 summarizes teachers' estimates of the relative importance of science in the school curriculum.

TABLE 6.2

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW IMPORTANT DO YOU THINK ELEMENTARY/JUNIOR SECONDARY/SENIOR SECONDARY SCIENCE SHOULD BE IN A STUDENT'S SCHOOLING?"

Response choices	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
More important than all other subjects	0	1	1
More important than most other subjects	3	18	27
Equal to other subjects	64	80	70
Less important than most other subjects	33	1	2
Less important than all other subjects	1	0	0

As can be seen from Table 6.2, a large change occurs between elementary and junior secondary school. From the child's point of view, the change must be dramatic. At grade eight, science becomes more important to his/her schooling. The student coming into grade eight is suddenly confronted with a well equipped laboratory, more hours of science instruction, and generally a science specialist as teacher.

Significantly, a full one-third of elementary science teachers feel that science is less important than most other subjects in the curriculum. This may result in little emphasis being placed on science by those teachers.

Teachers were asked for their opinions as to how school and district administrators perceive the importance of science education at their particular level of instruction. The responses are shown in Table 6.3. Half the elementary teachers feel that school administrators perceive science to be less important than most other subjects.

TABLE 6.3

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "IN YOUR OPINION, HOW DO SCHOOL AND DISTRICT ADMINISTRATORS PERCEIVE THE IMPORTANCE OF ELEMENTARY SCHOOL SCIENCE?"

Response choices	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
More important than all other subjects	0	0	0
More important than most other subjects	1	7	0
Equal to other subjects	49	81	79
Less important than most other subjects	49	11	13
Less important than all other subjects	1	0	0

6.2.1 Recommendations Regarding the Priority of Science Education at the Elementary Level

We recommend that

- if the new elementary science programs are to realize their full potential, the Ministry of Education, Science and Technology raise the priority that is placed on these programs by increasing the time allotted to elementary science. This action would, as a result, raise the priority placed on science by elementary teachers. It should be mentioned that elementary science activities make excellent vehicles for the learning of other subjects such as mathematics and language arts
- the Ministry of Education, Science and Technology initiate a study to determine methods of raising the awareness of elementary school administrators and elementary teachers as to the importance of science in elementary schooling. Factors which might be explored in such investigations include: the science background of elementary administrators, the perceptions of the informed public as to the priority of science in the elementary curriculum, the abilities of elementary children to learn elementary science, and the possible uses of in-service courses in science education for elementary school administrators.

6.3 Teachers' Ability to Cope with Science Teaching

6.3.1 Teachers' Desire to Teach Science

Teachers were asked if they would avoid teaching science altogether if they had a choice. Responses are summarized in Table 6.4. Most teachers seem to enjoy teaching science as a subject. Eleven percent of elementary teachers responded that, given a choice, they would avoid teaching science. Senior secondary teachers were the most positive about teaching science.

TABLE 6.4

PERCENT OF MALE AND FEMALE ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "IF YOU HAD A CHOICE, WOULD YOU AVOID TEACHING SCIENCE ALTOGETHER?"

Response choices	Percent of Teachers			
	Elementary		Secondary	
	Males	Females	Junior	Senior
Yes	8	12	7	2
Undecided	12	13	8	4
No	80	76	86	95

Those who would avoid teaching science tend to be female elementary teachers who do not have a strong science background (typically one course or less in science methods). Junior secondary "avoiders" tend to be those who were teaching science as less than one-half of their total teaching load.

Generally, however, the responses to this question indicate that most teachers do not wish to avoid teaching science. Teachers were also asked if they were comfortable teaching science. Once again, there was a more positive response from those teaching the more senior courses. Naturally, those teachers with a stronger background in science also feel more comfortable teaching science. Responses are summarized in Table 6.5, on the following page.

TABLE 6.5

PERCENT OF MALE AND FEMALE ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "AS A RULE, ARE YOU COMFORTABLE TEACHING SCIENCE?"

Response choices	Percent of Teachers			
	Elementary		Secondary	
	Males	Females	Junior	Senior
Yes	73	58	91	96
No	6	9	2	0
In-between	20	33	7	3
No comment	1	1	0	6

6.3.2 Comparison Between Teachers' Preference Towards Science Teaching and Their Present Teaching Assignment

Teachers were asked "If given a choice, at which level would you prefer to teach?" (Question 17). Responses to this question were tabulated according to the level currently being taught by the teachers, as shown in Table 6.6.

TABLE 6.6

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "IF YOU HAD A CHOICE, AT WHICH GRADE LEVEL WOULD YOU PREFER TO TEACH SCIENCE?"

Response choices	Percent of Teachers		
	Elementary	Junior Secondary	Senior Secondary
None	6	3	0
Primary/Kindergarten	43	0	0
Intermediate	48	2	1
Junior secondary	2	43	1
Senior secondary	1	47	91
Post secondary	0	5	7

Elementary teachers indicated that they wish to teach at the elementary school level. Ten percent of primary teachers reported that they would prefer to teach in the intermediate grades, and 39 percent of the intermediate teachers would like to teach at the primary level. Senior secondary teachers also seem to be pleased with their present teaching assignments. The responses of junior secondary teachers reveal startling differences in comparison to other groups.

More than half the junior secondary science teachers expressed a desire to be assigned elsewhere in the education system; forty-seven percent would prefer to teach at the senior secondary level.

This finding has pointed out a most serious problem at the junior secondary level. Although most of the junior secondary teachers indicated that they wished to teach science and were comfortable doing so, many of them wished to teach science elsewhere in the system. This finding, coupled with less than satisfactory results on secondary student achievement tests (see Volume I) seems to indicate that there must be something seriously wrong at the junior secondary level.

We recommend that the British Columbia Teachers' Federation consider raising a special committee to investigate the problems involved in teaching science at the junior secondary level. This committee could investigate the sources of the dissatisfaction of many junior secondary teachers with their present positions. Such a study might examine teacher mobility, teacher transfer, working conditions, class size, the stress factors which result from teaching this age group, the level of prestige associated with the position, and the teacher training programs of universities.

It is further recommended that university faculties of education give consideration to training some teachers as junior secondary science specialists. Junior secondary science teachers are usually trained in the same way as senior secondary teachers and many of these student teachers have a specific degree in one science, such as Biology or Physics or Chemistry, and then go into a one-year education program. It may be that a teacher trained in this manner would see his true calling at the senior secondary level. Junior secondary science teachers must teach a variety of sciences, unlike their senior secondary colleagues who often teach only one specialty. It is recommended that a different type of training be offered to the junior secondary science teachers.

6.3.3 Secondary Science Teachers' Self-Ratings as Science Teachers

The secondary teachers were asked to rate their own teaching performance in science. Most rated themselves as good or excellent. Practically all the teachers chose to rate themselves rather than opt for the "no comment" category as shown in Table 6.7, page 59.

TABLE 6.7

PERCENT OF JUNIOR AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW WOULD YOU RATE YOUR TEACHING PERFORMANCE IN SCIENCE?"

Self-rating categories	Percent of Secondary Teachers	
	Junior	Senior
Poor	0	0
Below average	2	1
Average	21	13
Good	57	63
Excellent	15	19
No comment	6	4

6.3.4 Marking Loads and Preparation Time

6.3.4.1 Preparation Time Given During School Hours

Secondary teachers were asked how many hours per week they were given during school time and how much time they actually need for preparation and marking. The responses to these two questions are shown in Table 6.8. For purposes of comparison, only the responses of full-time science teachers were considered. Teachers at the junior secondary level are generally given somewhat less time for preparation and marking than are teachers at the senior level. Thirty-one percent of full-time junior secondary teachers and 24 percent of full-time senior secondary teachers reported that they receive less than two hours per week of in-school time for preparation and marking. Teachers in both assignments reported that they require much more time than they are given.

Bivariate comparisons revealed a number of interesting patterns. Teachers with little or no science training and part-time science teachers tended to indicate that they require fewer hours of preparation time than do the full-time science teachers. Well qualified teachers with little teaching experience and teachers with larger classes indicated that they require more time than other teachers for preparation.

TABLE 6.8

PERCENT OF JUNIOR AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW MANY HOURS PER WEEK ARE YOU GIVEN DURING SCHOOL HOURS" AND "HOW MANY HOURS PER WEEK DO YOU NEED TO PREPARE AND MARK FOR YOUR SCIENCE CLASSES?"

Number of hours per week	Percent of Secondary Teachers			
	Junior		Senior	
	Given	Needed	Given	Needed
No time during school hours	3		5	
Less than one hour	5	2	4	0
1 - 2 hours	23	12	15	9
3 - 4 hours	59	23	57	19
More than four hours	10	63	19	71

There was a clear expression of interest, at the secondary level, in having more in-school time for preparation and marking. In another part of the questionnaire, teachers gave this a high priority, and reported feeling it would substantially increase the quality of education in their classrooms.

It should also be noted that elementary teachers receive virtually no in-school time for the preparation of science equipment and materials. This situation must be especially difficult for those who teach science to more than one class and for those who are teaching programs such as STEM and the Materials Based Program, which require the preparation of many materials. If teachers are to have their pupils actively involved with science materials, some provision should be made to give elementary teachers in-school preparation time.

Recommendations Regarding In-school Preparation Time

We recommend that

- where possible, schools increase the in-school preparation and marking time for secondary teachers, especially for those now receiving less than three hours of preparation time per week
- the Ministry of Education, Science and Technology provide for in-school preparation time for elementary teachers when calculating the funding formula for school districts.

6.3.4.2 Marking Loads at the Secondary School Level

More than sixty percent of secondary science teachers reported that they mark all student lab write-ups. The remainder (except for 2 percent) reported that they mark a sample of student write-ups. Between fifty and seventy percent of the teachers reported providing detailed comments on over half the lab reports submitted. Fifty-six percent of the junior secondary and fifty percent of the senior secondary teachers reported that their marking load was unmanageable or barely manageable. Teachers with larger classes more often reported unmanageable marking loads. The percent of secondary teacher responses to three pertinent questions are given below:

	<u>Percent of Secondary Teacher Responses</u>	
	<u>Junior</u>	<u>Senior</u>
How do you handle the marking of students' lab write-ups?		
I don't mark any write-ups	2	2
I mark all write-ups	59	68
I mark write-ups for a sample of the students for each experiment	2	3
I mark each student's write-up for a sample of experiments	33	24
I mark a sample of students' write-ups for a sample of experiments	3	4
What proportion receive detailed comments?		
None	5	3
Very few, well below half	31	26
Few, about half	29	25
Quite a few, well over half	21	30
All	8	16
How manageable is your marking load in science?		
Unmanageable	10	7
Barely manageable	47	51
Quite manageable	43	42

In other parts of the survey teachers indicated that much emphasis had been placed on students completing lab exercises from sets of instructions and then writing the labs for homework. This pattern was especially common at the junior secondary level. A vicious circle seems to have developed at the secondary level. Students seem to spend a great deal of time doing and "writing up" labs. Teachers then spend much of their time marking these formal lab reports. Emphasis might be better placed on other instructional strategies and upon examining indicators of student learning other than written labs. We recommend that teachers consider whether some of their professional time could be put to more effective use.

6.3.5 The Ability of Elementary Science Teachers to Cope with the New Programs

Elementary teachers were asked how well they were able to cope with the new program. Responses are summarized in Table 6.9. Seventy-five percent of elementary teachers reported that they were coping quite well with the demands placed upon them in implementing a new curriculum. Those using the STEM program indicated that they are having difficulty while those on the Materials Based Program tend to be managing the best. Those experiencing difficulty in coping tend to be young primary teachers with two to five years of teaching experience. Those who are not comfortable teaching science and those who would avoid teaching science also tended to indicate that they are not coping. In general, though, most teachers indicated that they were handling the extra burden of a new curriculum rather well.

TABLE 6.9

PERCENT OF MALE AND FEMALE ELEMENTARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW DO YOU FEEL ABOUT THE DEMANDS MADE ON YOU IN IMPLEMENTING THE NEW SCIENCE CURRICULUM?"

Responses on implementation of new science curriculum	Percent of Elementary Teachers		
	Total	Males	Females
I can't cope with it	3	2	3
Sometimes I find it too demanding	21	16	24
Generally I can cope	51	51	51
No problem in this area	24	31	22

6.3.5.1 Secondary Teachers' Perceptions of Students' Attitudes Towards Science

Secondary teachers were asked "How has student interest and motivation in learning science at school changed over the last four or five years?" The teachers chose the options as follows:

	Percent of Secondary Teachers	
	Junior	Senior
No opinion	20	9
Cannot notice any change	36	41
Motivation seems to have increased	19	26
Motivation seems to have decreased	24	25

There is no obvious pattern to these responses.

6.4 Summary

Teachers at all levels, particularly senior secondary teachers, thought that their portion of the B.C. science curriculum was worthwhile. Generally, teachers felt that science instruction at their level was equal in importance to most of the other subjects, but among elementary teachers one-third felt that science instruction has less importance. About half the elementary teachers suggested that their administrators shared this view.

Elementary and senior secondary science teachers indicated that they were content with their present teaching assignments. In contrast, a large proportion of junior secondary science teachers wish to be re-assigned elsewhere (particularly to the senior level) possibly indicating a serious morale problem at the junior secondary level. Secondary teachers indicated that they consider themselves to be competent teachers.

Nearly one-third of secondary teachers (31% junior secondary and 28% senior secondary) get less than three hours per week of in-school time for preparation and marking. Elementary teachers receive almost no in-school preparation time. More than half the secondary teachers indicated that they felt that their marking load was barely manageable or unmanageable. Teachers called for more time for marking and preparing.

Secondary teachers reported no marked change over recent years in student motivation or interest in science.

6.5 Summary of Recommendations: Chapter 6

We recommend:

- 6.5.1 That the Ministry of Education, Science and Technology raise the priority that is placed on elementary science by increasing the time allotment suggested for elementary schools.
- 6.5.2 That the Ministry of Education, Science and Technology initiate means for raising the level of awareness of elementary administrators and of elementary teachers to the importance of science in the elementary curriculum.
- 6.5.3 That the British Columbia Teachers' Federation form a special committee to investigate the problems involved in teaching science at the junior secondary level.
- 6.5.4 That university faculties of education consider training some teachers as junior secondary science specialists.
- 6.5.5 That further research be initiated to examine the degree to which attitudes expressed by junior secondary science teachers are shared by teachers of other subjects at this level. Such research should be designed to allow for a comprehensive examination of the junior secondary school as it exists in British Columbia at the present time.

- 6.5.6 That where possible, the allowance of time for preparation and marking at the secondary level be increased, especially for those teachers now receiving less than three hours of preparation time per week.
- 6.5.7 That the Ministry of Education, Science and Technology make provision for in-school preparation time for elementary teachers when determining the funding formulas for school districts.
- 6.5.8 That secondary teachers examine the amount of emphasis placed upon the routine assigning and marking of formal lab reports in order to determine if there are better uses for their professional time.

CHAPTER 7

TEACHER OPINIONS ON THE EDUCATION OF SCIENCE TEACHERS

7.1 Pre-service Teacher Education

Elementary teachers were asked "How adequately did your teacher education program prepare you for teaching elementary science as outlined in the new Interim Guide (1977)?" Thirty-five percent responded "very adequately", and 33 percent responded "somewhat inadequately". Only 29 percent responded "adequately", while three percent chose "very inadequately". Teachers using the STEM program were more likely to rate their training as inadequate than teachers using the other programs.

The ratings of their pre-service education in the teaching of science by the secondary teachers of science are shown in Table 7.1.

TABLE 7.1

PERCENT OF JUNIOR AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW ADEQUATELY DID YOUR PRE-SERVICE TEACHER EDUCATION PROGRAM IN SCIENCE PREPARE YOU FOR TEACHING SCIENCE?"

Response choices	Percent of Teachers	
	Junior Secondary	Senior Secondary
Very inadequately	15	21
Somewhat inadequately	32	25
Adequately	33	37
Very adequately	11	14
I had no teacher education in science	8	3

Sixty-eight percent of elementary teachers, 47 percent of junior secondary science teachers, and 46 percent of senior secondary science teachers thought that their pre-service teacher education had been inadequate. Generally, the younger, less experienced teachers tended to rate their training more negatively. Among the secondary teachers, experienced teachers with science education majors were more inclined than others to rate their training as adequate. Physics teachers were the most positive.

Elementary teachers were the most negative in their assessment of teacher training. Evidently, these teachers felt that their training had not prepared them well enough for implementing the new science programs, and the ones using the STEM program most frequently rated their pre-service training to be inadequate.

Teachers were also asked to indicate how much emphasis they considered should be placed on several aspects of their training as science teachers.

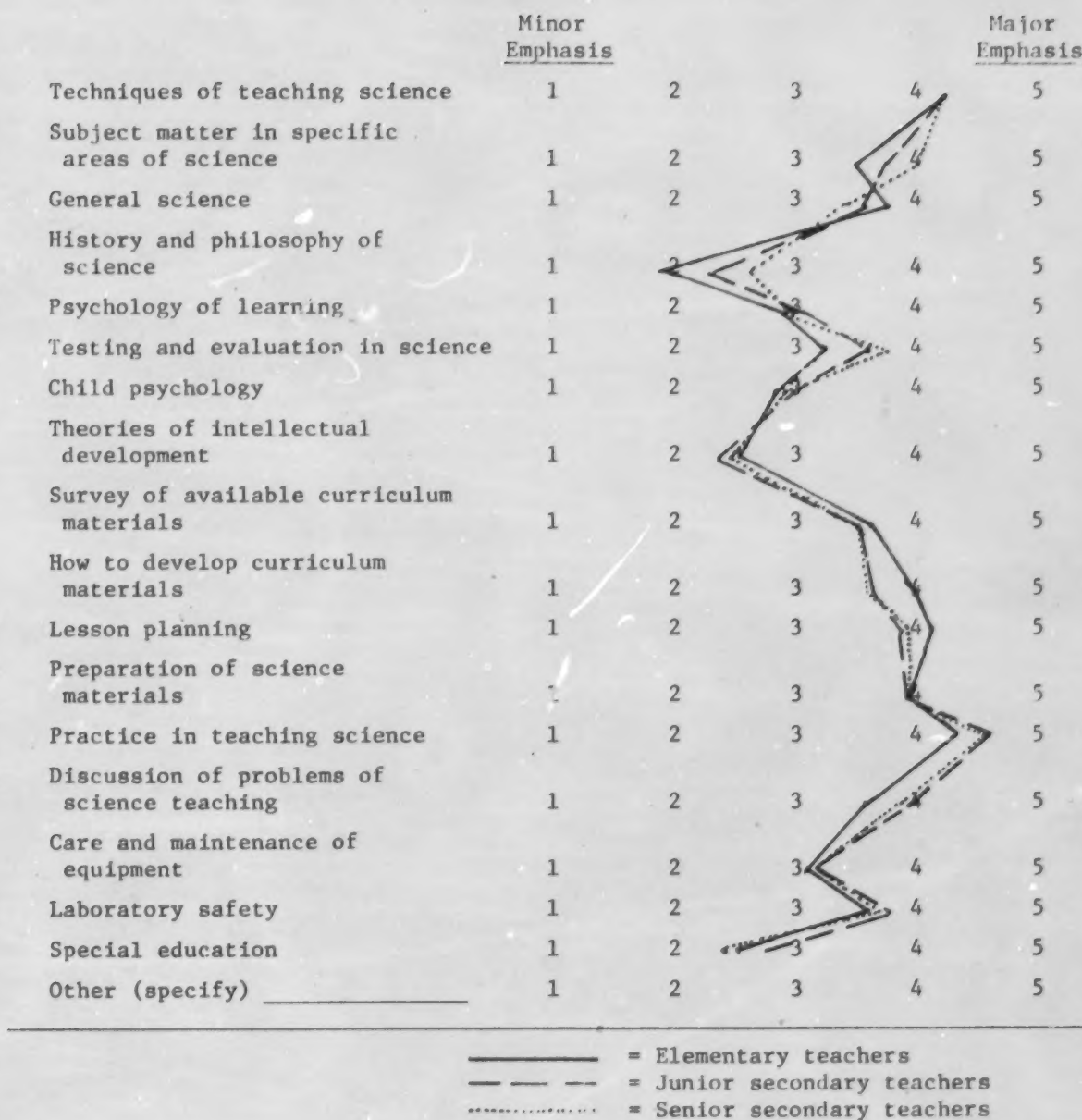
Elementary teachers wished their training to stress practical aspects of teacher training such as teaching techniques, materials development, surveys of various available curricula, lesson planning, preparation of science materials, and practice teaching. Elementary teachers wanted less emphasis on foundations such as history and philosophy of science, child psychology, and theories of intellectual development.

With junior secondary teachers, a similar pattern emerged. Forty-seven percent rated their teaching as adequate and once again these teachers suggested that their training should emphasize the practical teaching components of the program. Practice teaching in science, methods of science teaching, discussion of problems which relate to content were suggested as program components to be stressed. Other suggested components were curriculum development, testing and evaluation, and materials care and development. According to junior secondary teachers, the program should de-emphasize educational foundations and special education.

Senior secondary teachers suggested emphasis on practical aspects and on subject matter (content). Senior secondary teachers wanted less emphasis on special education, theories of intellectual development, and history and philosophy of science.

These findings are summarized for all groups in Figure 1 on the following page.

FIGURE 1



Means, on a five-point-scale increasing from Minor to Major Emphasis, of the responses of elementary and secondary teachers to the question, "How much emphasis should be placed on each of the (above) in preparing student teachers to teach science?"

(2.0 > S.D. > 0.6)

7.2 In-service Education

7.2.1 Teachers' Inservice Requirements

When teachers were asked how much in-service they felt they required this year to do a good job of teaching science, the responses shown in Table 7.2 indicated a strong demand for in-service. Eighty-seven percent of the elementary teachers; 78 percent of the junior secondary science teachers; and 79 percent of the senior secondary science teachers indicated a need for some form of in-service. The preferred types of in-service education were a one afternoon workshop session of three to five hours, and several sessions of the same duration.

TABLE 7.2

PERCENT OF PRIMARY, INTERMEDIATE, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW MUCH IN-SERVICE EDUCATION DO YOU FEEL YOU REQUIRE THIS YEAR TO DO A GOOD JOB TEACHING SCIENCE?"

In-service education needed	Percent of Teachers			
	Elementary		Secondary	
	Primary	Intermediate	Junior	Senior
None	11	15	22	21
3 - 5 hours (1 afternoon workshop)	44	36	32	29
Several sessions of 3 - 5 hours	34	39	39	43
An intensive refresher course	10	9	7	7

The responses of elementary teachers indicated that women were requesting in-service more than the men were. Eighty-nine percent of women teachers wanted some form of in-service education. The request for in-service was generally pervasive throughout the various age categories of the respondents. Teachers over sixty years of age were not requesting as much in-service but even 68 percent of the group was interested. Teachers on the STEM program asked for the largest amounts of in-service education. "Avoiders" (see Chapter 6) of science teaching at the elementary level indicated a need for much in-service education.

At the secondary level, younger, less experienced teachers were requesting the most in-service time, and at this level also, women asked for more in-service training than did the male teachers.

7.2.2 Teacher Evaluation of Present In-service Programs Available Within the School/District

Teachers were asked to rate the effectiveness of the in-service program provided in their school or district. Responses are shown in Table 7.3. It was apparent that teachers felt that their needs for in-service education were not being provided. About forty percent of the secondary school teachers reported that no science in-service was being provided. Only 35 percent of elementary teachers, 15 percent of junior secondary teachers, and 18 percent of senior secondary teachers had positive perceptions of their in-service programs. Evidently, in-service programs were received as least effective at the secondary teachers level. This finding was consistent with views of secondary teachers regarding the lack of leadership and coordination at the district level.

TABLE 7.3

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "HOW EFFECTIVE IS THE SCIENCE IN-SERVICE EDUCATION PROGRAM PROVIDED IN YOUR SCHOOL/DISTRICT?"

In-service education rating	Percent of Teacher Responses		
	Elementary	Junior Secondary	Senior Secondary
No science in-service program is provided	25	39	43
Very ineffective	13	19	17
Somewhat ineffective	27	27	24
Fairly effective	32	4	17
Very effective	3	1	1

7.2.3 Types of In-service Programs Requested by Teachers

Teachers were asked to indicate which forms of in-service training they felt to be of value. Responses are shown in Table 7.4. Once again, teachers indicated preference for practical forms of education. Types of in-service activities asked for by teachers, in order of popularity, were

- informal meetings with other teachers
- workshops presented by other teachers
- visits to other classrooms
- workshops conducted by university science education instructors
- formal university courses.

Among the elementary teachers, the most valued workshops were those presented by teachers. Informal meetings with other teachers and workshops presented by teachers were the most popular with secondary teachers. More secondary teachers than elementary teachers indicated that forms of university in-service training were of value.

A number of interesting findings emerged from bivariate comparisons of several types of in-service training. Informal meetings with other teachers were more often requested by teachers whose science background were stronger. Those who had had in-service sessions from university science educators tended to value this form more than other teachers did. Experienced teachers valued the presentations of university science education instructors more than did the less experienced teachers. Generally the stronger the teachers' backgrounds, the more often they valued all forms of in-service. Younger, less experienced teachers valued classroom visitations more often than did the older, more experienced teachers. In the sample of teachers answering the questionnaire at the junior secondary level, there were 107 teachers who also responded that they had little or no science training, and who still did not want in-service training. It may be that these teachers were reluctant, part-time science teachers who were covering science courses to fill gaps in the school's timetable.

TABLE 7.4

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY TEACHERS WHO CHOSE EACH OPTION IN RESPONSE TO "WHICH FORMS OF IN-SERVICE HAVE YOU HAD AND WHICH FORMS DO YOU FEEL ARE OF VALUE?"

Forms of in-service education	Elementary		Junior		Secondary	
	Have Had	Of Value	Have Had	Of Value	Have Had	Of Value
Informal meetings with other science teachers	48	55	85	84	91	87
Informal meetings with university science education instructors	14	21	31	33	48	53
Informal meetings with scientists	9	15	21	31	33	42
Workshops presented by other teachers	61	67	66	66	76	71
Workshops presented by university science education instructors	29	36	41	42	52	50
Workshops presented by scientists	4	11	21	31	29	40
Workshops presented by Ministry of Education officials	3	8	9	9	16	21
Formal (credit) university courses in science	31	30	35	41	39	47
Formal (credit) university courses in science education	31	34	28	31	29	32
Visits to other classrooms	28	48	41	52	50	55

7.2.4 Teachers' Willingness to Participate in In-service Education Programs

Nearly all teachers indicated a willingness to attend in-service education programs. About one-half indicated that they would probably participate in workshops held after school or on weekends, and a further 21 to 31 percent of teachers indicated that they would definitely participate. Approximately twice as many would participate if release time was given.

TABLE 7.

PERCENT OF ELEMENTARY, JUNIOR SECONDARY AND SENIOR SECONDARY
TEACHERS WHO INDICATED WILLINGNESS TO PARTICIPATE IN IN-SERVICE
PROGRAMS

Extent of willingness to participate in in-service programs	Percent of Teachers					
	After school or on weekends			If release time granted		
	Elem.	Junior	Senior	Elem.	Junior	Senior
Definitely would not participate	4	3	3	1	1	1
Probably would not participate	14	14	11	3	4	2
Probably would participate	51	51	48	34	38	36
Definitely would parti- cipate	21	24	31	59	54	57
Cannot say	10	8	7	3	4	4

7.3 Summary of Recommendations: Chapter 7

We recommended:

- 7.3.1 That as it is obvious that teachers were requesting in-service education in very large numbers and that present in-service programs, from the teachers' point of view, are either not available or are ineffective, the Ministry of Education, Science and Technology support a comprehensive program for in-service education of science teachers.
- 7.3.2 That the Ministry of Education, Science and Technology, in co-operation with the British Columbia Science Teachers' Association and the various university faculties of education, develop a program of in-service education. Priority should be given to having this program delivered by a group of expert classroom teachers. This group could be trained by the faculties of education and would form the nucleus of the in-service program. To maximize the effectiveness of the program, some form of release time should be given utilizing some of the "professional days" which are set aside for the professional development of teachers.
- 7.3.3 That the university faculties of education, re-examine the balance between practical and theoretical aspects of their pre-service teacher education programs, bringing the emphasis more in line with the needs that have been identified by the science teachers.

CHAPTER 8

TEACHERS' INSTRUCTIONAL PRACTICES

8.1 Homework at the Secondary Level

Teachers were asked how much science homework they typically assigned per week to each student. Responses are shown in Table 8.1.

TABLE 8.1

PERCENT OF JUNIOR AND SENIOR SECONDARY TEACHERS WHO REPORTED
ASSIGNING VARIOUS AMOUNTS OF SCIENCE HOMEWORK TO EACH STUDENT

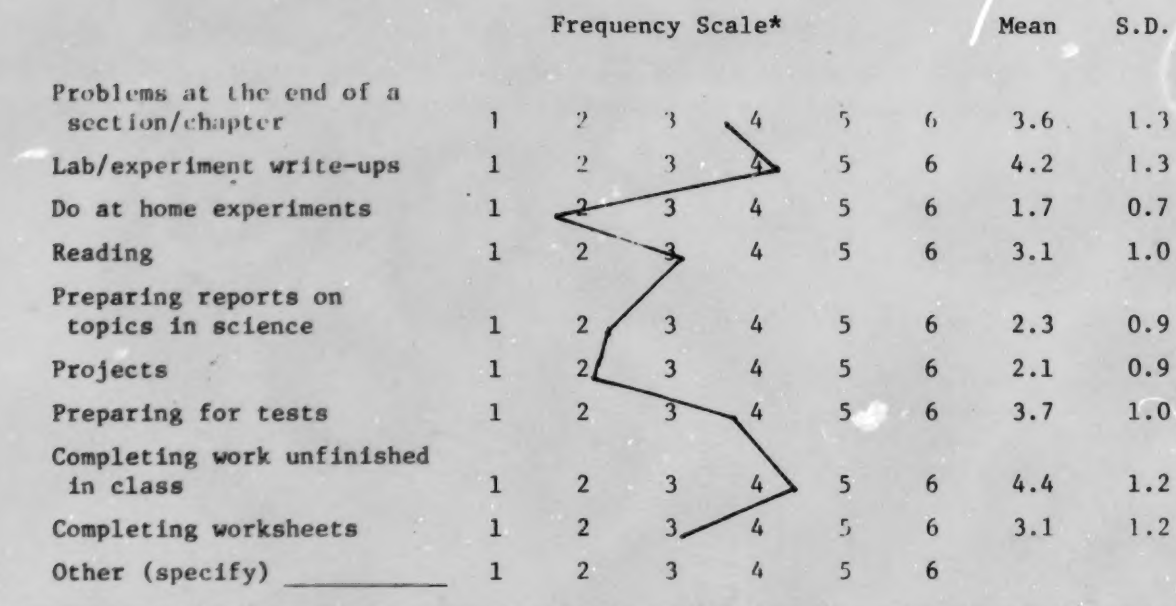
Number of hours of homework assigned per week	Percent of Teachers	
	Junior Secondary	Senior Secondary
0	3	2
1	40	6
2	40	32
3	14	36
4 or more	3	24

Most of the junior secondary teachers (80 percent) reported assigning one or two hours of homework per week. Of the senior secondary teachers 68 percent reported assigning two or three hours per week.

Among junior secondary teachers, those who were science education specialists, that is those 44 percent whose major concentration was in science education, assigned more homework than did the other teachers. At the senior secondary level, biology teachers assigned less homework than did chemistry and physics teachers.

Teachers were also asked to indicate how often they assigned various types of homework. Their responses are shown in Figure 2 on the following page. The most common forms of homework were lab write-ups, and the completion of unfinished class work. Other fairly common types of homework included problems at the end of the chapter, reading, and preparing for tests. Teachers seldom or never had students conduct experiments or do science projects or reports as homework. The homework pattern which emerged was a rather dull regimen of lab write-ups and incompleting class work. A more diverse and imaginative use of homework assignments seems to be needed at the secondary level.

FIGURE 2



* Scale: 1) Never 2) Rarely (one or twice during course) 3) Occasionally 4) About half of the time 5) Frequently 6) Very Frequently (almost every class period)

Means of responses from junior and senior secondary teachers to the question, "How often do you assign homework in each of the categories?", are shown in Figure 2 above.

Senior secondary teachers in the various subject disciplines used homework assignments differently. Biology teachers assigned chapter problems occasionally and less often than did physics teachers. Lab write-ups were assigned frequently, especially by biology teachers. Reading homework was assigned most often by biology teachers, more than one-half of whom assigned reading frequently. Biology teachers were the most inclined to ask for topical reports; physics or chemistry teachers rarely or never assigned reports. Chemistry and physics teachers virtually never assigned projects as homework. Test preparation was mainly assigned by biology teachers. More than half of all senior science teachers assigned unfinished class work as homework.

8.2 Evaluation Strategies

Teachers were asked to estimate what percentage of their evaluation of students was based on each of a number of methods. Those most frequently used were teacher-made objective tests and student lab write-ups. Elementary teachers seemed to have employed the greatest variety of evaluation strategies, including consideration of pupil attitudes in class; work habits; teacher-made objective tests; anecdotal records; and projects and reports. The elementary teachers rarely or never used standardized objective tests, individual work contracts, or self-reporting by students. One-half the elementary teachers never used subjective tests.

Junior secondary science teachers commonly used teacher-made objective tests and student lab write-ups, but seldom or never used student self-reports, individual work contracts, anecdotal records, or oral tests.

At the senior secondary level, the repertoire of evaluation techniques was still rather narrow. Most commonly employed were teacher-made objective tests; lab write-ups; and subjective tests. Seldom or never used were student self-reports; anecdotal records; oral tests; and individual work contracts. One-half of the senior secondary science teachers considered general attitudes in class for up to 20 percent of a student's mark. From the questionnaire data it was impossible to determine whether the latter response involved the acquisition of scientific attitudes or merely general compliance.

The findings indicate that teachers ought to be encouraged to expand their repertoire of evaluation techniques. More subjective testing is needed in the elementary grades and more use of anecdotal records is indicated at the secondary level. The increased use of standardized tests at each level may provide teachers with useful feedback. There should be less emphasis on routine laboratory write-ups in the evaluation process.

8.3 Classroom Activities of Pupils

Teachers were asked to report how often students were engaged in certain activities. For comparison purposes the students were asked the same questions in the student attitude instrument. It was felt that the perspectives of both groups would be valuable to determine ways in which teachers could have their students engaged in different situations.

8.3.1 Teacher Estimates of the Frequency of Various Classroom Activities

Figure 3 shows the means for estimates by the elementary and the junior secondary teachers of the frequency with which the various classroom activities are undertaken. (Figure 3 - Page 82) The senior secondary teachers reported a pattern of activities very similar to the junior secondary, except for slightly more frequent use of lectures, note-taking, and graphing.

At the secondary level, one general pattern emerged. According to teacher reports, students appeared to be learning science most frequently by doing lab experiments from sets of instructions and reporting observations in their own words writing up labs. In the process, students became involved with the associated processes of discussing possible errors in the experiments, graphing, applying, interpreting for themselves experimental results, describing and reporting observations for themselves in their own words, discussing experimental results with other students and reading from textbooks. Secondary teachers indicated that their students spent over half of their time carrying out experiments from sets of instructions. It is interesting to note that the secondary curriculum guides recommended that about 40 percent of students' time be spent on lab-centred learning. Having students do investigations at home, or make up their own experiments were reported as infrequent practices by many junior and senior secondary teachers.

Elementary teachers reported placing much less emphasis upon a single methodology. Elementary teachers rarely reported having students do problems at the end of a section of a book or memorize scientific information. Although elementary teachers reported that they had students involved in science processes, it would appear that the activities were less determined by external sets of instructions than at the secondary level. Elementary teachers reported with somewhat greater frequency than other teachers having students make up

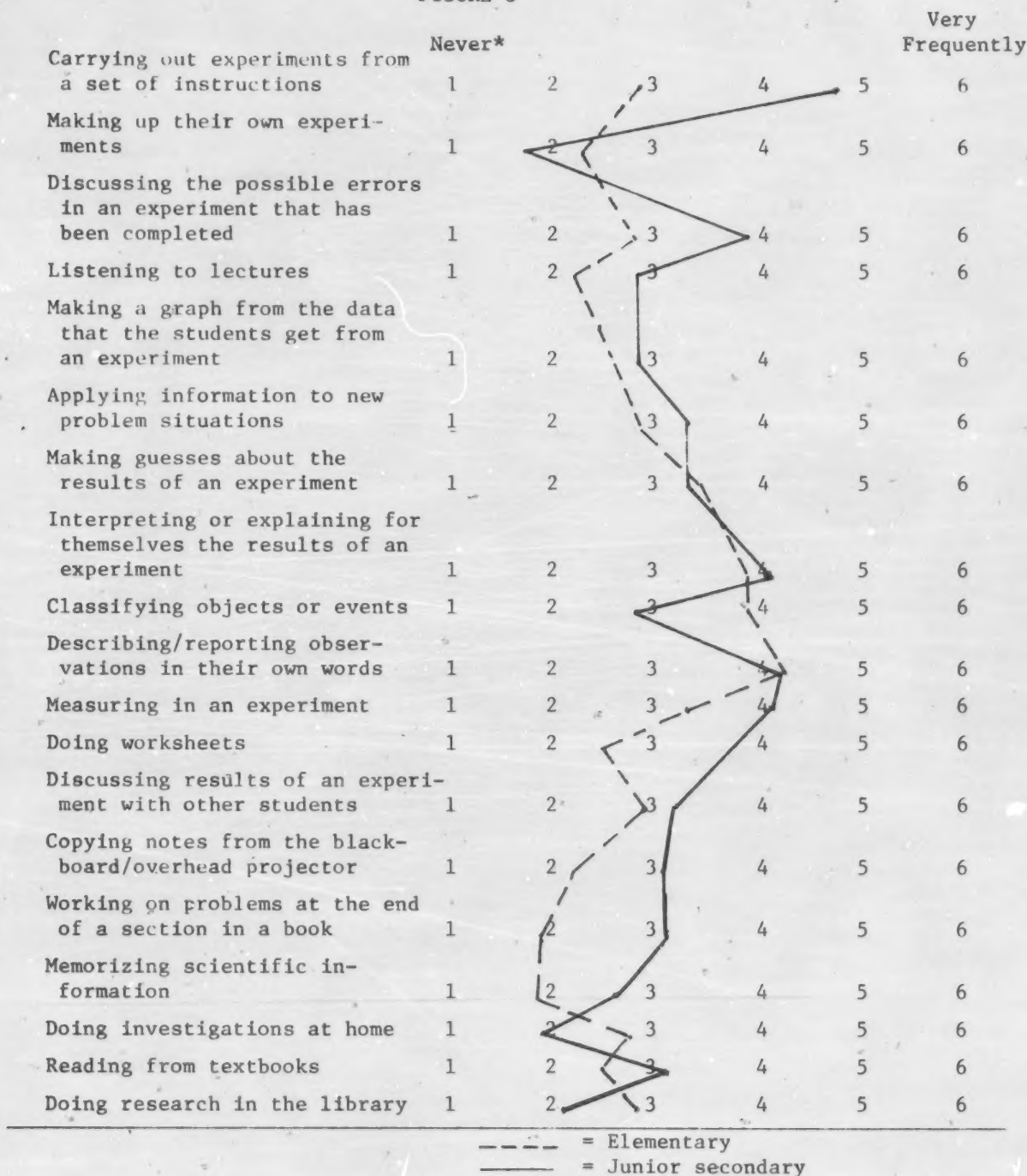
their own experiments or doing investigations at home. As a group, the profiles of elementary stood out from the profiles of the secondary teachers. More emphasis seems to have been placed upon classification at the elementary grades. Less emphasis was reported by elementary teachers on listening to lectures, copying notes, working on problems at the end of the chapter, memorizing scientific information, and reading from textbooks. In the elementary grades, teachers reported less frequently involving pupils in discussing the possible errors in an experiment and in measuring when compared to secondary reports. As in the secondary grades, elementary teachers frequently had their pupils describing or reporting observations in their own words.

More emphasis on the science processes seemed to be occurring in the Materials Based Program. The least amount of science process activity was reported by those teachers using the Exploring Science series. Experimentation generally was done only occasionally in the elementary grades. More actual student activity involving experimentation may be needed at the elementary level.

Generally, though, elementary activity seemed to more student directed than secondary activity which seemed more teacher and textbook directed.

It would appear that secondary teachers, particularly junior secondary teachers, could expand their teaching repertoire by employing more student-directed experimentation. Revision of the present curriculum and textbook series at the junior secondary level would also be likely to increase the variety of student activities.

FIGURE 3

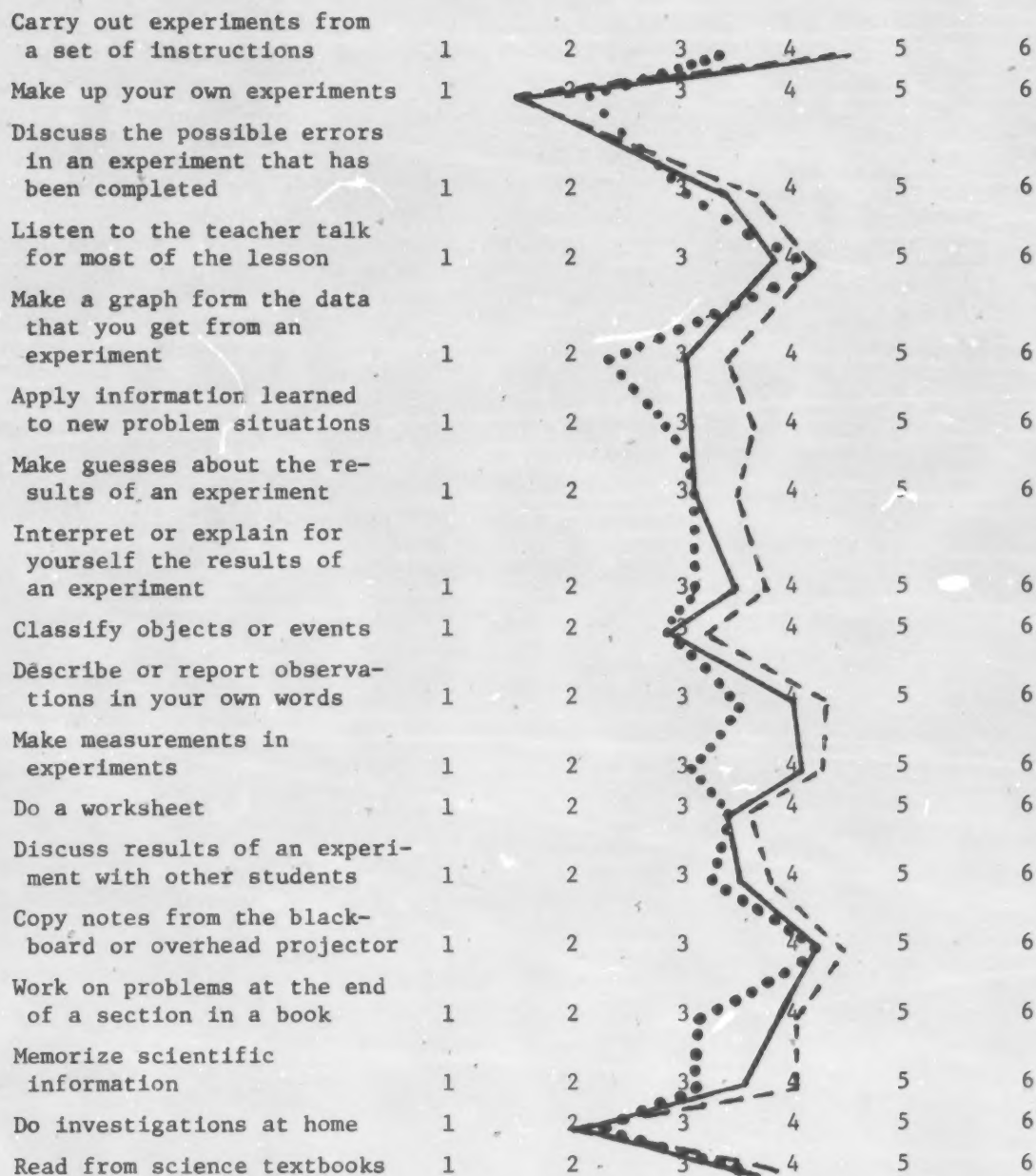


*Scale: 1) Never 2) Rarely (one or twice during course) 3) Occasionally
 4) About half of the time 5) Frequently 6) Very Frequently

Means of responses of elementary and junior secondary teachers to the question "How often do you engage the students in your science class in each of the (above) activities?"

(1.3 S.D. 1.0)

FIGURE 4



Scale as for figure, page 82

Means: Student Responses

Grade 7.....
Grade 9_____
Grade 11----

Means of student responses to "How often are you usually required to do each of the (above) in science classes?" (From attitude instrument described in Volume 1)

Secondary students, especially at the junior secondary level, have probably come to expect that doing science simply involves following lab recipes and handing in lab reports. Changing this vicious cycle of expectations will likely be a difficult enterprise. With the implementation of a new curriculum, an accompanying inservice program would be a necessity.

8.3.2 Comparison Between Teacher and Student Views of Classroom Activities

In order to make some comparison between what teachers reported they were having students doing in science classes and what students reported they were doing, the mean responses on the parallel question in the student attitude instrument are shown in Figure 4, page 83. The reader should be cautious in comparing the responses of virtually all of the science teachers in the province with the responses of a sample of grade seven, grade nine, and grade eleven students. Particularly in the elementary comparison there is some problem in generalizing grade seven responses to the entire elementary scene.

Although some interesting inferences can be made from the comparisons, such conclusions should be somewhat guarded because of the limitations described above. Figure 4 indicates that the conclusion that secondary teachers rely too much upon one instructional strategy seems to be borne out by the students' responses. Secondary students, particularly at the junior secondary level, reported spending over half of their time carrying out experiments from sets of instructions and reporting and describing experiments in their own words, while listening to the teacher talk for most of the period and copying notes from the blackboard or overhead projector. Secondary students reported that they rarely or never conducted their own experiments which they made up themselves and rarely or never did investigations at home. If the consumers' perspective is to be believed, an even duller picture was painted at the secondary level by the students than by the teachers. Apparently either students overestimated or teachers underestimated how much "teacher talking" has gone on in the classrooms. At all levels, even at elementary, students reported a great deal of teacher talking. Grade seven and grade eleven reported the greatest amount of "teacher talk" overall. There was agreement between students and teachers that students were only occasionally asked to apply information to new problem situations.

The elementary teachers reported a greater frequency of classification activity than did the grade seven students. Grade seven pupils reported a great deal more copying of notes from the blackboard than was reported by elementary teachers in general. Some of this reliance upon listening and copying at the grade seven level may have been due to the fact that most grade seven teachers did not have the new curriculum materials available at the time of the assessment and were largely supplementing the science course by "using their own ideas". For this reason alone, it can be seen that the grade seven group was an unfortunate choice for these comparisons because grade seven students were not following a typical elementary program and were not typical of elementary pupils.

Secondary students tended to report more emphasis upon the following activities than the teachers had reported:

- listening to lectures
- doing worksheets
- copying notes from the blackboard
- working on problems at the end of the chapter or section
- memorizing scientific information
- reading from textbooks.

Secondary pupils apparently saw their science activities as somewhat more rigorous than teachers perceived the activities to be.

In general there was considerable agreement in one major respect. Both secondary teachers and pupils, particularly at the junior-secondary level felt that the most frequent student activities were the carrying out of experiments from sets of instructions, interpreting or explaining the results of an experiment and the reporting of observations in the students' own words. Students felt that they also spent over half of the time copying teacher prepared notes. Students also tended more than teachers to perceive the emphasis of their science activities on the more rigorous elements such as memorization, reading and doing problems.

Teachers should be encouraged through in-service education to expand their repertoire of teaching techniques. At the junior secondary level far too much emphasis has been placed upon one methodology: students doing scores of science labs which have taken the form of series of science "cook-book" experiments to be followed religiously by write-ups. A new set of junior science readers and lab books would likely help. Complete revision of the junior secondary curriculum may not in itself be enough to change this pattern but certainly would be a help to teachers. In-service education which stresses innovative teaching techniques is also necessary if classroom practices are to change.

More actual science experimenting is also needed at the elementary level. Hopefully, as the new curriculum becomes better implemented, and supplemented with inservice and proper supply equipment and materials, the level of pupil activity will increase.

8.4 Provision for Individual Differences

8.4.1 Elementary and Junior Secondary Provisions for Individual Differences

Elementary and junior secondary teachers were asked what provisions had been made in their science classes and in their schools for individual differences in pupil ability to learn science. A surprising 52 percent of the elementary teachers and 29 percent of the junior secondary teachers responded that no special provisions existed.

TABLE 8.2

PERCENT OF ELEMENTARY AND JUNIOR SECONDARY TEACHERS WHO INDICATED VARIOUS PROVISIONS IN THEIR CLASS OR SCHOOL FOR INDIVIDUAL DIFFERENCES¹

Provision for individual differences	Percent of Teachers	
	Elementary	Junior Secondary
No special provisions	52	29
Continuous progress	22	14
Individualized instruction	18	18
Learning assistance classes	7	40
Ability grouping by classes	5	38
Ability grouping within the class	24	14

¹ Respondents could choose more than one option

As can be seen from Table 8.2, the junior secondary teachers reported a greater variety of provisions for individual differences. Junior secondary schools generally attempted to meet individual differences by learning assistance classes and ability grouping by classes.

At the elementary level there were significant relationships between the science training of the teachers and the kinds of attempts which were made to meet individual difference. More of the science majors than other teachers reported provision for ability grouping within the class, learning assistance classes, individualized instruction and continuous progress. The teachers who had taken one or no science courses at university or college level most often reported no special provisions. Apparently, elementary science teachers with a science background regarded science as a subject with sufficient priority to merit provision for individual differences.

As the new elementary science programs become implemented, elementary teachers should attempt to provide for the individual abilities of their pupils to do science. Making these provisions would be consistent with giving elementary science a greater priority in the overall curriculum.

8.4.2 Junior Secondary Provisions for Special Science Programs

Junior secondary teachers were asked to indicate any special science programs which existed in their schools. Results are shown in Table 8.3. Terminal science courses for students who were leaving school in junior secondary years were reported by 35 percent of the teachers. Special electives for advanced students were reported by only about one-fifth of the teachers. Technology-oriented science courses were rather rare, being reported by 11 percent of the teachers.

TABLE 8.3

PERCENT OF JUNIOR SECONDARY SCIENCE TEACHERS INDICATING VARIOUS SPECIAL SCIENCE PROGRAMS AT THE JUNIOR SECONDARY LEVEL IN THEIR SCHOOLS

Special Programs	Percent of Teachers
Terminal science courses for students who are leaving school in junior high years	35
Special learning assistance science courses for low achievers	41
Technology-oriented science courses	11
Recreation science courses (either courses or extra-curricular clubs -- lapidary, science photography, nature study)	21
Special electives or sections for advanced students	19

It was somewhat disturbing to find that science recreation courses or extra curricular clubs occurred in only about one-fifth of the schools and classrooms. Conscious attempts should be made to stimulate and provide for the needs and interests of students, and some form of recreational science such as science clubs, lapidary, nature study, science fairs, should occur in every secondary school in the province.

Elsewhere in the survey, many of the senior secondary science teachers were supportive of the introduction of alternative science courses at the senior level to better meet student needs. Obviously, this topic requires much study and attention in B.C. schools. If scientific literacy in the general population is to be an aim of the schools, attempts must be made to cater to the individual needs and abilities of the students. Present senior secondary science courses can legitimately be accused of being rather elitist - appealing to a very small population of the students. Enrolment in senior courses such as physics has declined to the point where secondary science teachers have become concerned. Besides having academic science courses for those going on in science, schools should also provide more general interesting science courses for the majority.

8.5 Teachers Views on Trends in Science Education

Elementary and junior secondary teachers were asked to determine whether or not they would like to see more, less or the same amounts of a number of trends in science education.

The elementary teachers reported their desire for more of the following:

- background information for teachers (68%)
- provision of materials rather than textbooks for teaching science (59%)
- environmental education (59%)
- locally developed programs (55%)
- outdoor education (54%)
- integration of science with other subject areas (53%)
- activity centred learning (51%)

The junior secondary teachers reported their desire for more:

- background information for teachers (68%)
- provision by district of materials for teaching science (64%)
- provincially developed alternates to present programs (63%)
- environmental education (55%)
- locally developed programs (54%)
- outdoor education (53%)

More elementary teachers tended to desire activity and discovery centered learning than did the junior secondary teachers. Elementary teachers tended to be more negative about the provincial and district learning assessment program. A majority of both groups wished the amount of external assessment to remain at the same level as presently exists.

8.6 Changes Which Teachers Felt Would Most Improve Science Learning

Probably the most important question in the teaching and learning survey asked teachers which changes would be likely to affect the quality of science learning in their classrooms. This question provides an appropriate perspective for interpreting the results. Consequently the reader should place great weight on teachers' responses to this item.

More than half the science teachers felt that the items below would improve or greatly improve the quality of science education in their classrooms. Most concerns emerged among the junior secondary and elementary teachers.

The elementary teachers thought the following changes would be likely to improve the quality of science learning in their classrooms:

1. Increased provision of in-service (84%)
2. Increased availability of equipment and materials (79%)
3. Smaller class size (71%)
4. More time to prepare and mark (68%)
5. More science books in the library (65%)
6. More university science courses taken by the teacher (64%)
7. Fewer subjects/levels to teach (63%)
8. Better quality of equipment (60%)
9. More leadership and coordination at district level (59%)
10. More leadership and coordination at school level (57%)
11. More convenient storage space for equipment (57%)
12. More direct input by the teacher into the purchase of equipment (52%)
13. More time allocated to science (51%)

The junior secondary teachers thought the following changes would likely improve the quality of science learning in their classrooms:

1. Provision of wider selection of printed materials (texts) (86%)
2. Smaller class size (84%)
3. More time for preparation and marking (83%)
4. Increased provision of in-service (73%)
5. Fewer classes to teach (71%)
6. Increased availability of equipment and materials (67%)
7. Complete revision of junior high program (65%)
8. More science books in the library (59%)
9. Better quality of equipment (58%)
10. More university courses in science taken by the teacher (56%)
11. Fewer subjects/levels to teach (54%)
12. More time allocated to science (53%)

The senior secondary teachers thought the following would be likely to improve the quality of science learning in their classrooms:

1. More time for preparation and marking (77%)
2. Provision for a wider selection of printed materials (texts) (72%)
3. Fewer classes to teach (69%)
4. More time allocated to science (67%)
5. Smaller class size (62%)
6. Better quality equipment (58%)
7. More university courses in science taken by the teacher (56%)
8. More science books in the library (56%)

8.7 Summary of Recommendations: Chapter 8

We recommend:

- 8.7.1 That teachers use homework in more diverse, imaginative ways.
- 8.7.2 That revision of the present curriculum and textbook series take place at the junior secondary level.
- 8.7.3 That teachers be encouraged, through in-service education, to expand their repertoire of teaching techniques. At the secondary level, and especially at the junior secondary level, too much emphasis has been placed upon a methodology involving students doing progressions of labs, followed up by written lab reports.

CHAPTER 9
CURRICULUM AND TEXTBOOKS

9.1 The Interim Elementary Science Program

In 1977, a new Interim Elementary Science Program was published, and implementation of the new program began. It was felt that before the new program was finalized this assessment would provide valuable assistance to those who were involved in making final decisions at the Ministry of Education, Science and Technology, school district, school and classroom levels. Examination of the percentage responses in Appendix A would be valuable to readers concerned with the new program.

9.1.1 Availability of Elementary Programs

Teachers were asked which of the options in the new program were available to them in their schools. STEM was available to 77 percent of the teachers, Exploring Science was available to 74 percent, and the Materials Based Program was available to 51 percent. Among the kindergarten teachers separately, 11 percent reported that no program was available, while another 27 percent indicated they did not know what was available.

9.1.2 Options Actually in Use

Most teachers (66 percent) reported that they used a combination of the options, and a further 29 percent used one option supplemented by their own ideas. Only 5 percent of the elementary teachers reported using one option exclusively. The largest percentage of teachers who used one option exclusively was at the grade five level (12 percent).

9.1.3 Decision Makers

Teachers were asked who chose the options. About one-third of the teachers did not know who made the decision; a further 36 percent indicated that the decision was made by an advisory group of teachers and/or principals; seventeen percent responded that district supervisory staff made the decision; while only 4 percent indicated that the decision was made by the school principal. All groups of decision makers tended most often to select a combination of the options. The second most common choice by decision makers was the STEM program, except for the school principals who were more likely to have chosen Exploring Science.

9.1.4 Reasons for the Choice of Programs

Forty percent of teachers responded that they did not know what the main reason was for the choice of their particular science program, indicating that many teachers were not part of the decision making process. Twenty-nine percent thought the options were chosen because they were considered to have provided the best science education. Twenty percent thought the options were chosen because

they were felt to be "most approachable for teachers". According to the teachers' responses, the Materials Based Program was most often chosen because it was expected to provide the best science education, while the other two options were most often chosen because they were more readily available or were easily approached by teachers.

9.1.5 Methods by Which Teachers Supplement the Program

Teachers were asked how they supplement the elementary science program. The responses to this question were as follows:

- Six percent indicated "no opportunity to supplement".
- Eight percent indicated "no need to supplement".
- Thirty-four percent indicated "extra reading". The STEM users most often chose this response (41%).
- Forty-one percent indicated "extra content". The STEM users most often chose this response (46%).
- Seventy-six percent indicated "extra activities". The Materials Based users most often chose this response (84%).
- Twenty-four percent indicated "extra equipment". The Materials Based users most often chose this response (34%).

Most elementary teachers seem to have felt the need to supplement the program in a variety of ways. Oddly enough, extra content and reading were used more to supplement the textbook centered options while activity and materials were used more to supplement the Materials Based Program.

9.1.6 Supply of Materials

Teachers were asked "Are sufficient materials available to your classroom for teaching the selected program to your grade level?" Responses for each grade level are shown in Table 9.1.

TABLE 9.1

PERCENT OF ELEMENTARY TEACHERS AT EACH GRADE LEVEL WHO CHOSE EACH OPTION IN RESPONSE TO "ARE SUFFICIENT MATERIALS AVAILABLE TO YOUR CLASSROOM FOR TEACHING THE SELECTED PROGRAM TO YOUR GRADE LEVEL?"

Response choices	Percent of Teachers								
	Total	K	1	2	3	4	5	6	7
Sufficient materials are available	49	62	53	49	47	51	44	50	44
Insufficient materials are available	44	28	41	45	44	43	51	44	51
No materials are available	3	5	3	3	4	3	2	3	4
I don't know	3	5	4	3	4	2	4	2	1

Equipment problems seem most acute at the intermediate grade levels, where about half the teachers indicate that sufficient materials are not available.

9.1.7 Advice to the Ministry of Education, Science and Technology Regarding the New Curriculum

Teachers were asked to advise the Ministry of Education, Science and Technology about the new elementary science curriculum. Seventy-nine percent advised the retention of the new programs with some modifications. Only nine percent of the teachers felt that extensive modifications were necessary or that curriculum revision should start again.

TABLE 9.2

PERCENT OF ELEMENTARY TEACHERS AT EACH GRADE LEVEL WHO CHOSE EACH OPTION IN RESPONSE TO "WHAT ADVICE WOULD YOU GIVE TO THE MINISTRY OF EDUCATION ABOUT THE NEW ELEMENTARY SCIENCE PROGRAMS?"

Advice About New Elementary Program	Percent of Teachers								
	Total	K	1	2	3	4	5	6	7
Keep it generally as it is or with minor changes	30	19	28	25	32	31	34	35	29
Keep it, but increase the choices available	28	19	23	25	32	31	34	35	29
Keep it with modifications	21	9	20	19	24	22	26	28	17
Modify it extensively	5	2	4	6	3	6	3	2	10
Start again	4	2	2	1	4	6	3	7	6
I don't know	12	42	12	12	9	7	9	7	12

Teachers' responses generally indicate basic agreement with the elementary program. The Ministry offers three alternative programs to teachers and to schools.

It should be noted that almost half the kindergarten teachers felt that they did not know enough about the programs to make a judgement. In-service seems particularly necessary at this level.

9.1.8 Teachers' Preference Among the Three Options

Teachers' preference among the three options as expressed in response to question 45, are shown for each grade level in Table 9.3.

TABLE 9.3

PERCENT OF ELEMENTARY TEACHERS AT EACH GRADE LEVEL EXPRESSING PREFERENCE WITH RESPECT TO THE THREE OPTIONS IN THE ELEMENTARY SCIENCE CURRICULUM

Program Preference	Percent of Teachers								
	Total	K	1	2	3	4	5	6	7
Materials Based Program	24	39	20	26	20	23	19	24	25
STEM	24	6	24	30	28	21	34	23	20
Exploring Science	31	10	27	25	35	39	32	34	33
I don't know	21	45	28	19	18	16	14	18	21

The Materials Based Program was most often selected by teachers with stronger backgrounds, e.g., those with science education majors. The Exploring Science series was most preferred, especially by those teachers having only one course in science methods and little or no science background. Apparently, the Exploring Science Program appealed most to teachers with little science background, the STEM series appealed to teachers with some science background and the Materials Based Program appealed to those teachers with the most science education.

9.1.9 Reasons for Elementary Teachers' Preference for the Various Programs

The teachers were given a checklist of reasons for justifying their preference of option. The percent of the teachers preferring a given option who indicated each reason on the checklist are shown below in Table 9.4

TABLE 9.4

PERCENT OF THE ELEMENTARY TEACHERS PREFERRING MATERIALS BASED, STEM, AND EXPLORING SCIENCE WHO CHECKED EACH ITEM OF A LIST OF REASONS FOR THE PREFERENCE

Reasons for Preference	Percent of the Teachers Who Preferred:		
	Materials Based	STEM	Exploring Science
Materials readily available	44	34	36
More readable	5	41	54
More relevant to students	71	46	51
Easier to teach	19	40	49
Easier to prepare	16	37	43
Better teacher's guide	8	39	24
Better balance between content and process	40	53	48
Right amount of activity	59	48	44
Right degree of structure	20	36	44
Suited to my background	34	28	32

The Materials Based Program was preferred because it was more relevant, more materials were available, and it suggested the right amount of pupil activity. The STEM series was most preferred because it was a better balance between process and content and had better teachers' guides. The Exploring Science series was chosen because it was more readable, easier to teach, easier to prepare, and had the right amount of structure.

9.1.10 Teachers' Ratings of the Various Options on a Set of Criteria

According to the option teachers indicated most familiarity with, teachers were categorized as Materials Based, STEM, and Exploring Science. Teachers were asked to rate their particular programs on five-point scales according to a set of criteria. The means for each group are shown on the following pages in Table 9.5 and Figure 5.

Table 9.5 show the means and standard deviations on each criterion for each of the groups, together with F-ratios (d.f. = 2,1490) for tests of significance of differences among the three groups. With the exception of relevance to students, the differences among the means are significant for each criterion, indicating that the three programs are rated differently by the three groups of teachers.

The Materials Based Program was given an overall rating of satisfactory or better by 85 percent of those familiar with the option. The Materials Based Program was rated high on availability of materials, student relevance, good pupil activity, and student interests. The greatest weakness of the Materials Based Program concerned the difficulty of preparation. Other concerns involved teachers' guides, difficulty in teaching, and content selection.

The STEM program was rated as satisfactory or better by 94 percent of those familiar with the option. STEM's highest rating was on the usefulness of the teachers' guides, and other high ratings were for relevancy and balance between content and process. The profile in Figure 5 demonstrated that STEM was a compromise program, midway between Exploring Science and the Materials Based Program. The major weakness of the option was the availability of materials.

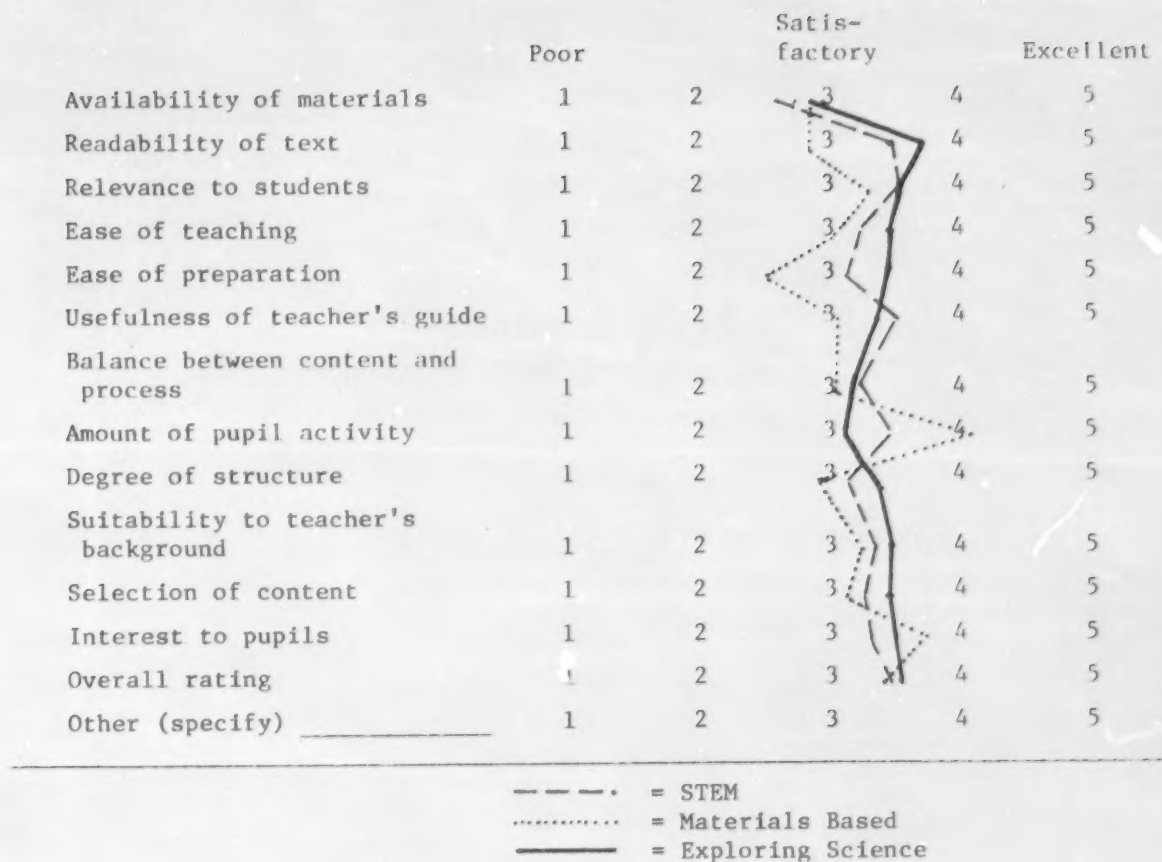
Exploring Science was rated as satisfactory or better by 93 percent of those familiar with the program. High ratings were given on text readability, ease of teaching and preparation, balance between content and process, structure and selection of content. Exploring Science was judged weakest concerning the availability of materials.

TABLE 9.5
MEANS AND STANDARD DEVIATIONS OF TEACHERS' RATINGS OF EACH PROGRAM

	Materials Based		STEM		Exploring Science		F ¹	p
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Availability of materials	3.0	1.1	2.7	1.1	2.9	1.0	6.1	0.002
Readability of text	2.9	0.9	3.5	0.9	3.6	0.9	51.1	0.000
Relevance to students	3.4	1.0	3.5	0.8	3.5	0.9	1.3	0.26
Ease of teaching	3.0	1.0	3.4	0.9	3.6	0.8	50.4	0.000
Ease of preparation	2.8	1.0	3.2	0.9	3.4	0.8	59.9	0.000
Usefulness of teacher's guide	3.1	1.0	3.6	0.9	3.4	1.0	28.9	0.000
Balance between content & process	3.0	1.1	3.4	0.9	3.3	0.9	21.7	0.000
Amount of pupil activity	4.0	0.9	3.5	0.9	3.2	1.0	94.7	0.000
Degree of structure	3.0	1.0	3.3	0.8	3.4	0.8	35.7	0.000
Suitability to teacher's background	3.3	1.0	3.5	0.8	3.5	0.8	8.35	0.000
Selection of content	3.1	0.9	3.4	0.9	3.5	0.9	22.1	0.000
Interest to pupils	3.7	0.9	3.6	0.9	3.6	0.8	4.9	0.008
Overall rating	3.3	0.9	3.5	0.7	3.6	0.8	9.5	0.000

¹ d.f. = 2, 1490

FIGURE 5



Means ratings of the three elementary science options by three groups of teachers.

9.1.11 Actual Use of Printed Materials

Teachers were asked to report the frequency with which they used each of a number of printed materials. A five-point scale was provided as follows:

1	2	3	4	5
Never	Rarely	Sometimes	Frequently	Constantly

The percent of teachers who responded on each point of the scale for each of the materials are shown in Table 9.6.

TABLE 9.6

PERCENT OF ELEMENTARY TEACHERS WHO CHOSE EACH CATEGORY IN RESPONSE TO "HOW OFTEN DO YOU OR YOUR STUDENTS ACTUALLY USE THE FOLLOWING (PRINTED MATERIALS)?"

Frequency of Use of Materials	Percent of Teachers Responding				
	Never 1	Rarely 2	Some- times 3	Fre- quently 4	Constant- ly 5
STEM textbooks	41	15	26	16	3
Exploring Science textbooks	36	12	26	21	5
Materials based units	22	18	38	17	5
Materials based Program Interim Guide	49	21	22	7	1
Elementary Science Interim Guide	35	22	34	8	2
Locally-developed units	33	21	31	12	3
Teacher-developed units	7	11	35	35	4
B.C.T.F. lesson aids	30	27	35	7	1

Because programs were being implemented, and many schools were still receiving books at the time of the assessment, interpretations of this table should be guarded to say the least. Most frequently used were Exploring Science textbooks and teacher developed units.

9.1.12 Method by Which the Grade Seven Teachers Were Supplementing the Program

Grade seven teachers had not yet received the new programs at the time of the assessment. In order to determine what they did while awaiting the new curriculum, teachers were asked what course of action they were following.

Five percent of the teachers reported they were using grade 6 materials, 14 percent had materials from the old program, and 15 percent were using Materials Based Program materials. Forty-four percent of the teachers reported that they were using their own ideas. (12 percent chose "other")

9.1.13 Summary of Teachers Responses Regarding the Elementary Curriculum

Elementary teachers generally felt that the three options were satisfactory or better. Most reported using a variety of materials. It would appear that each of the three options appealed to a unique clientele.

The Materials Based Program was regarded as a strong program in terms of student activity and interest, availability of equipment and relevance. The weaknesses perceived in this option were: teachers' guides, difficulty in teaching and preparation, and poor content selection.

The Exploring Science program was considered to be strong in readability of texts, ease of teaching and preparation, and balance between content and process. STEM was rated highest on the usefulness of teachers' guides. STEM was perceived as a compromise program on many criteria. Both STEM and Exploring Science were rated as less than satisfactory in terms of availability of materials.

9.1.14 Recommendations Concerning the Elementary Science Program

We recommend that

- curriculum planners at the elementary level finalize the implementation of the program based upon the concept of three alternative choices
- provision be made to ensure that adequate materials are available
- some improvement be made in the Materials Based Program by providing better teachers' guides and a better selection of content

9.2 Junior Secondary Curriculum

In Chapter 8 it was reported that 65 percent of junior secondary teachers felt that complete revision of the curriculum would improve the teaching and learning of science. In other components of the science assessment a number of serious problems seemed to exist at the junior secondary level. As a major recommendation, based upon many different types of input, the Contract Team recommended to the Ministry of Education, Science and Technology that there be a complete revision of the junior secondary science curriculum.

9.2.1 Teachers Opinions Regarding the Revised Grade Eight Text

During the 1978 school year a revised version of the grade eight text was provided to schools. Teachers were asked how the new edition compared to the original version. Sixty-two percent felt that the revision was somewhat or considerably better. Only 30 percent of the teachers felt that the book was considerably better. In general, changes to the books seemed to be appreciated by the teachers. A surprising 25 percent of the junior secondary teachers responded that they were not familiar with the books.

9.2.2 Desired Changes in the Grade Nine and Ten Lab Texts

Teachers were asked what changes were desirable in the present grade nine and ten texts. Only 2 percent of the respondents felt that no changes were necessary. In order of frequency, they suggested:

1. More related background reading (72%)
2. More summary notes and questions (60%)
3. More easy experiments for less able students (58%)
4. More line drawings to illustrate procedure (44%)
5. More questions at the end of the chapter (43%)
6. More challenging experiments for brighter students (41%)
7. More coloured photographs to illustrate procedure (39%)
8. More questions at the end of each lab (33%)
9. More detail describing procedure (27%)
10. More structure and sequence (26%)

In interpreting these suggestions the reader should keep in mind that junior secondary teachers tended to place an inordinate emphasis on students doing experiments from sets of instructions.

9.2.3 Suitability of Background Reading Materials

Junior secondary teachers have been provided with sets of background readers for student use. Over the years there has been considerable criticism of these books. The Contract Team wanted to determine if the books were being used and how the teachers judged the suitability of the Reading About Science series. Eleven percent of teachers did not use the books, and only 22 percent felt that they were generally satisfactory. Half the teachers indicated the books

were too difficult and sixty percent felt that they did not relate to lab topics.

Perhaps the over-reliance of junior secondary science teachers on one methodology, i.e. students doing labs from sets of instructions, could be explained from the above findings. Teachers may have felt it necessary to rely on the lab texts because the science readers seemed too difficult and too unrelated to the labs.

9.2.4 Degree of Emphasis Placed on the Various Content Areas of the Junior Secondary Curriculum

Teachers were asked how many hours that they spent on the various content components of the curriculum. For ease of comparison the mean category responses were plotted and compared to the suggested percentage given in the junior secondary curriculum guides. These data are presented in Figure 6, on the following page.

At the grade eight level, earth sciences seem to have been neglected. In grade nine, chemistry and biology appeared to be emphasized. Once again, in grade ten, earth science was neglected while chemistry and physics were emphasized. The means, however, did not provide adequate reflection of these trends. In grade nine, 36 percent of the teachers reported devoting 0-9 hours of time to space science. In grade ten, 37 percent of the teachers taught 0-9 hours of earth science and forty percent taught 0-9 hours on sound and wave motion. Teachers interested in the number of hours spent on various topics should refer to the percentage frequencies in Appendix A.

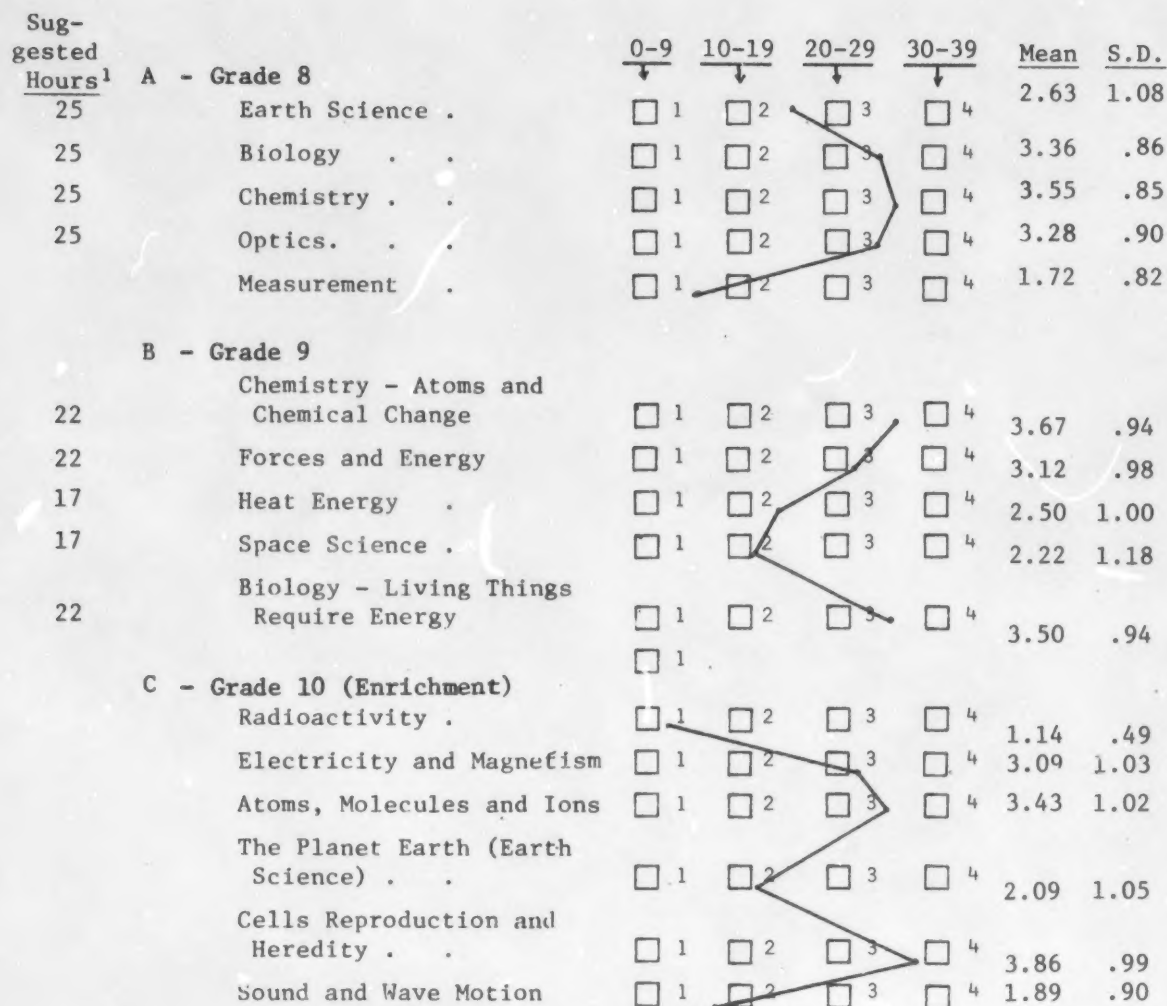
Generally, it was found that teachers were placing little emphasis on the earth sciences. In British Columbia, where the second largest industry is mining, this seems unfortunate. Recently, modern geology has been frequently reported upon in scientific journals. Plate tectonics and continental drift are exciting discoveries which should be presented to students who live on the boundary between two crustal plates.

It is recommended that more time be spent in teaching earth science. Necessary in-service provisions are also indicated in this area.

9.2.5 Usefulness of Non-Prescribed Printed Materials

Teachers were asked how useful they found a number of printed materials to be. Most useful were B.C.T.F. lesson aids (45 percent), Labtext in Science (43 percent), locally developed units (34 percent), Mixtures in Chemistry (26 percent) and Ecology: Field Research in Science (21 percent). The majority of teachers were unaware of the non-prescribed materials listed.

Figure 6



¹According to Curriculum Guides

Means on a six-point scale of responses by junior secondary teachers to the question: "About how many hours is usually spent by your classes on each of the (above) sections of junior high school?"

The scale points were: 0-9, 10-19, 20-29, 30-39, 40-49, 50+. Because the means did not encompass them, the last two scale points are omitted from the figure.

9.2.6 Summary of Junior Secondary Curriculum

The revised grade eight text was seen by 62 percent of the teachers as an improvement. Suggestions made for the grade nine and ten lab texts included more related background reading, more summary notes and questions, and more easy experiments for the less able students. A written comment, frequently reiterated, also referred to the need for a detailed course outline for non-academic students. Over 62 percent of the junior secondary teachers felt that complete revision of the curriculum would raise the quality of education occurring in their classrooms. The Reading About Science series has been used rather extensively but a majority of teachers were very critical of the books either because of them being unrelated to lab topics or being too difficult.

Junior secondary teachers emphasized biology, chemistry and some units in physics, such as optics and electricity, while avoiding units such as heat energy, sound, and wave motion. The enrichment unit on radioactivity was ignored by many teachers. Earth science and space science appeared to be neglected. At the grade eight level 42 percent of the teachers taught earth science for less than the suggested time. The Planet Earth, in grade ten, received 0-9 hours of instruction by 38 percent of the teachers.

9.2.7 Recommendations for the Junior Secondary Science Curriculum

We recommend that

- the junior secondary curriculum undergo revision
- complementary reading materials be developed for lab activities
- any new curriculum provide for individual differences
- teachers not treat geology and space sciences as "poor cousins" in science

9.3 Senior Secondary Curriculum

9.3.1 Teachers' Views on the Introduction of a General Science Course

Teachers were asked for their views on the introduction of a general science course at the grade eleven level for some students. Fifty-two percent indicated their support while 35 percent expressed opposition. Biology 11 teachers were the most divided on the issue. All other groups of teachers were generally in favor of the concept of a general science alternative.

9.3.2 The Curriculum and Materials in Physics

Physics teachers were asked how frequently they used certain printed materials. A Laboratory Course in Physics was used regularly by 80 percent of the teachers, while the PSSC text was used regularly by 51 percent. Project Physics was used occasionally by 20 percent of the teachers, and other materials were seldom used.

In response to the idea of a more general physics course to meet the needs of more students, only 13 percent of the physics teachers indicated that the present course should be retained exclusively. Sixty-three percent indicated that the present courses should be retained and a more general course introduced for some students. Eight percent indicated that the present course should be replaced with a more general course, while 16 percent indicated that the grade 11 course only should be replaced with a more general course. Eighty-three percent of the teachers would be prepared to teach a general course.

9.3.3 The Curriculum and Materials in Chemistry

The chemistry teachers were asked how frequently they used various printed materials in 1977-78, and which they would prefer to use in 1978-79. Their responses are shown in Table 9.7.

TABLE 9.7

PERCENT OF CHEMISTRY TEACHERS WHO INDICATED, FOR EACH CATEGORY OF VARIOUS MATERIALS, THE FREQUENCY OF USE IN 1977-78, AND WILLINGNESS TO USE THEM IN 1978-79.

Printed Material for Chemistry	Percent of Teachers Who Used Material			Percent of Teachers Who Would Like to Use Material Next Year (1978-79)
	Never	Occasion- ally	Regul- arly	
Keys to Chemistry	40	53	7	36
The Nature of Matter	43	41	16	35
Inquiries in Chemistry	23	32	45	74
The 'old' course (CHEM Study)	5	36	58	37

The chemistry teachers seemed to be using a variety of materials, with a preference for CHEM Study and Inquiries in Chemistry.

9.3.4 The Curriculum and Materials in Biology

The biology teachers were asked how frequently they used each of the printed materials on the Ministry of Education, Science and Technology approved list. The results are summarized in Table 9.8.

TABLE 9.8

PERCENT OF BIOLOGY TEACHERS WHO INDICATED NEVER, OCCASIONALLY, OR REGULARLY USING EACH OF THE PRESCRIBED BOOKS OR GUIDES

Printed Material for Biology	Percent of Teachers Who Reported Using Material		
	Never	Occasionally	Regularly
B.S.C.S. textbook (green version)	6	44	50
B.S.C.S. Biological Science: An Inquiry into Life Lab Text (yellow version)	13	60	28
B.S.C.S. Biological Science (blue version)	87	13	1
Laboratory and Field Investigations (Miller and Vance)	43	56	2
Laboratory Manual Biological Science (Gregory)	19	52	30
Laboratory Outlines in Biology (Abramoff and Thomson)	15	57	28
B.C. Curriculum Guide for Biology 11	21	52	27
Animals Without Backbones (Buchsbaum)	2	27	71
Resource Book of Test Items	47	38	15
Student Lab Outline (Ministry)	58	32	10
A Guide to the Study of Freshwater Biology (Weedham and Weedham)	13	72	15
Trees, Shrubs and Flowers to Know in B.C.	10	70	20
B.S.C.S. Lab Blocks: (1) Field Ecology	39	59	2
(2) Life in the Soil	46	53	1

When the Biology 11 teachers were asked to rate the suitability of the following materials for Biology 11, eighty percent or more rated them to be suitable or very suitable.

- Animals Without Backbones (96%)
- Trees, Shrubs and Flowers to Know (90%)
- BSCS (Yellow Version) (88%)
- A Guide to the Study of Freshwater Biology (86%)
- Laboratory in Biology (Abramoff and Thomson) (83%)
- Laboratory Manual Biological Science (Gregory) (80%)

In terms of allocation of time, teachers indicated the highest priority for diversity (usually taught 30-40 hours), followed by ecology (20-30 hours), optional material, and evolution.

Sixty-four percent of the Biology 11 teachers agreed there ought to be an alternative course at the grade eleven level concentrating on human biology. Ninety-two percent of the Biology 11 teachers responded that they would teach such a course if it were an option.

The Biology 12 teachers were asked to rate the suitability of the various Biology 12 materials prescribed for Bi. 12. Only Workbook of Investigations of Cells and Organisms was rated by a majority (56%) as unsuitable.

With respect to time allocation, more than half the Biology twelve teachers responded that they spent 50 hours or more on physiology. Cellular biology was generally taught for 30-40 hours and instruction with optional materials took up 20 hours or less. Seventy percent of the Biology 12 teachers taught evolution for 10 hours or less. As in Biology 11, evolution was the least emphasized theme.

When asked if they felt that the Biology 12 course was too content oriented, 64 percent of the teachers responded in the negative and 36 percent in the affirmative. Only about one-third of the grade twelve biology teachers felt that the course was too content oriented.

9.3.4.9 Summary of Senior Secondary Curriculum and Printed Materials

Senior secondary teachers were in favour of the introduction of an alternative general science course to better meet the needs of some students. For the same reason, physics teachers also felt that there needed to be a more general physics course. Most biology teachers favoured the introduction of an alternative grade eleven biology course which would stress human life science.

A number of prescribed texts were reported as not being used and others were in regular use. Senior secondary biology teachers did not tend to emphasize those parts of the courses dealing with evolution.

9.3.4.10 Recommendation Concerning Alternative General Science Courses

We recommend that

- the Ministry of Education, Science and Technology and school districts give serious consideration to the introduction of more general science courses at the grade eleven level, as alternatives to or in place of the present courses, to meet the needs of a wider range of students.

9.4 Summary of Recommendations: Chapter 9

We recommend:

- 9.4.1 That the Ministry of Education, Science and Technology immediately establish a curriculum revision committee to carry out a major revision of the junior secondary science program.
- 9.4.2 That the Ministry of Education, Science and Technology, as a priority item, increase the selection of texts and supplementary reading materials available to teachers of the present junior secondary science curriculum as long as it is in force.
- 9.4.3 That the Ministry of Education, Science and Technology continue with the new elementary science program as outlined in the Interim Guide (1977), taking into account the findings in this report.
- 9.4.4 That the Ministry of Education, Science and Technology and school districts give serious consideration to the introduction of more general science courses at the grade eleven level as alternatives to, or in place of, the present courses in order to meet the needs of a wider range of students.

APPENDIX A
TEACHER QUESTIONNAIRES

In this Appendix, the three survey instruments are reproduced, and the percent of teachers who chose each option for each question is reported.

TOEL

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SCHOOL CODE

DO NOT IDENTIFY YOURSELF ANYWHERE IN THIS BOOKLET

Strict Confidentiality will be Maintained

BRITISH COLUMBIA LEARNING ASSESSMENT PROGRAM

ELEMENTARY SCIENCE

A TEACHER QUESTIONNAIRE

We appreciate the fact that school programs at the present time are so varied that the questions posed here may not fit your school organization or philosophy. Where there is a lack of 'fit' between our questions and your organization or philosophy, please specify and comment. Use the last page for more detailed comment. In general, we would ask that you respond as fully as you can.

The purpose of the questionnaire is to provide useful information for modification to the Interim Guides, for research and for improving the teaching and learning of science.

Note: Please check or circle the appropriate response for each item. For some items, more than one choice may be marked. These items will be identified as multiple response items. All other items are to be responded to only once.

IMPORTANT

On the label on the envelope in which you received this questionnaire is marked a grade/year level corresponding to one of those below. Please check the appropriate box and respond to the questionnaire with this one grade level in mind, even though you may also teach other levels.

1 (10)

- | | | | | | | | | |
|--------------|---|---|---|---|---|---|--------------------------|---|
| Kindergarten | . | . | . | . | . | . | ☐ | 0 |
| Grade/Year 1 | . | . | . | . | . | . | ☐ | 1 |
| Grade/Year 2 | . | . | . | . | . | . | ☐ | 2 |
| Grade/Year 3 | . | . | . | . | . | . | ☐ | 3 |
| Grade/Year 4 | . | . | . | . | . | . | ☐ | 4 |
| Grade/Year 5 | . | . | . | . | . | . | ☐ | 5 |
| Grade/Year 6 | . | . | . | . | . | . | ☐ | 6 |
| Grade/Year 7 | . | . | . | . | . | . | ☐ | 7 |

368

(11)

Background and General Information

I. Years of teaching experience as of June 1978:

a) 1 or less	6
b) 2 - 5	30
c) 6 - 9	20
d) 10 - 13	16
e) 14 or more	28

(12)

II. Are you male or female?

a) male	33
b) female	66

(13)

III. How many courses in methods of teaching science have you taken?

a) none	8
b) one	64
c) major/concentration in science education	8
d) other (specify) _____	11

(14)

IV. When did you take your MOST RECENT course in methods of teaching science?

19 __ __

(15-16)

V. How old are you?

a) under 20 years	0
b) 20 - 24	8
c) 25 - 29	26
d) 30 - 34	21
e) 35 - 39	15
f) 40 - 49	18
g) 50 - 59	10
h) 60 and over	2

(17-18)

VI. How many students are in your largest science class this year?

a) 20 or less	14
b) 21 - 24	25
c) 25 - 28	33
d) 29 - 32	22
e) over 32	6

(19)

VII. How many college/university courses have you had in each of the following areas of science?

	0	1 - 3	4 - 7	8 or more	
a) Biology	39	54	5	3	(20)
b) Chemistry	58	38	3	1	(21)
c) Physics	68	29	2	1	(22)
d) Astronomy	88	11	0	0	(23)
e) Earth Science	59	35	3	2	(24)
f) General Science	32	64	3	1	(25)

VIII. (Multiple Response Item)

Which science courses have you taught so far? (Check more than one if appropriate.)

	This Year	Previous Years	
a) elementary science, kindergarten/primary .	48	50	*(26-27)
b) elementary science, intermediate . . .	49	54	(28-29)
c) science 8	1	7	(30-31)
d) science 9	1	4	(32-33)
e) science 10	1	3	(34-35)
f) Biology 11	0	1	(36-37)
g) Biology 12	0	1	(38-39)
h) Chemistry 11	0	1	(40-41)
i) Chemistry 12	0	0	(42-43)
j) Physics 11	0	1	(44-45)
k) Physics 12	0	0	(46-47)
l) Earth Science 11	0	0	(48-49)
m) Geology 12	0	0	(50-51)
n) special electives	0	0	(52-53)
o) other (specify) _____			(54-55)

Leadership

1. With reference to the elementary science program in your SCHOOL:
Which of the following best describes the form of leadership which exists?

a) There is a specially designated science coordinator or department head who is responsible for just the elementary grades	5	
b) There is a specially designated science coordinator or department head who is responsible for elementary <u>and</u> secondary grades	1	
c) There is a specially designated coordinator or department head who is responsible for science and one or more other subjects	2	
d) Leadership and coordination are performed by a working group of teachers in the school	12	
e) Leadership and coordination have been assumed by the principal, vice-principal or one of the teachers	17	
f) There is no particular form of leadership	60	
g) Other (specify): _____	3	(56)

2. In general terms, how do you rate this form of leadership?

a) Excellent	4	
b) Very good	12	
c) Satisfactory	54	
d) Unsatisfactory	26	
e) Very unsatisfactory	5	(57)

3. With reference to the elementary science program in your DISTRICT:
Which of the following best describes the form of leadership which exists?

a) There is a specially designated science coordinator or supervisor responsible for just the elementary grades	15	
b) There is a specially designated science coordinator or supervisor who is responsible for elementary <u>and</u> secondary grades	4	
c) There is a specially designated coordinator or supervisor who is responsible for science and one or more other subjects	13	
d) Leadership and coordination are performed by a working group of teachers in the district	19	
e) Leadership and coordination have been assumed by one of the administrators or teachers in the district	8	
f) There is no particular form of leadership	38	
g) Other (specify): _____	4	(58)

4. In general terms, how do you rate this form of leadership?

a) Excellent	3	
b) Very good	12	
c) Satisfactory	51	
d) Unsatisfactory	27	
e) Very unsatisfactory	7	(59)

Physical Facilities

5. How adequate are the following physical facilities for teaching science in your school? (Circle the appropriate number.)

	Not Needed	Very Inade- quate			Excellent	
a) lighting	8	4	9	42	24	12 (60)
b) storage space for science materials/equipment	1	31	26	27	12	3 (61)
c) storage space for dangerous materials . . .	28	26	14	18	10	4 (62)
d) storage space for student projects . . .	3	49	28	17	3	1 (63)
e) science preparation room	26	48	13	9	3	1 (64)
f) A.V. equipment	2	6	12	35	32	14 (65)
g) gas outlets	65	24	4	4	2	1 (66)
h) water outlets	4	25	19	32		6 (67)
i) electrical outlets	3	20	25	34	14	5 (68)
j) sinks or drainage facilities	1	24	20	34	15	7 (69)
k) flat-topped desks or tables	2	18	18	34	19	10 (70)
l) safety equipment	27	19	16	30	7	1 (71)
m) amount of work space per student	1	20	27	38	11	3 (72)

6. How systematically is the safety equipment checked in your science area/room/laboratory?

a) no safety equipment	59	
b) casually at best	16	
c) systematically; once a year	18	
d) systematically; more than once a year	6	(73)

Equipment/Materials

7. Apart from minor changes, how often have you had to adapt your teaching plans this year because of difficulty in obtaining the necessary science equipment?

a) never	16
b) seldom; about once or twice	40
c) fairly often; about three or four times	20
d) quite often; about five or six times	8
e) far too often; more than six times	7
f) I seldom plan to use equipment.	10

(74)

8. Overall, how do you rate the quality of the science equipment available to you?

a) excellent.	4
b) good	36
c) tolerable.	42
d) poor	13
e) very poor.	5

(75)

9. How much input do you have in deciding what science materials/equipment are to be purchased?

a) none	15
b) not nearly enough input	19
c) about right	66

(76)

10. Who maintains and accounts for the science equipment in your school?

a) each science teacher looks after his/her own equipment	38
b) each science teacher looks after certain equipment	5
c) a specially designated science teacher	36
d) head of science department	3
e) paid assistants.	3
f) nobody takes any responsibility	13
g) other (specify): _____	

(77)

11. (Multiple Response Item)

How do you usually get your science equipment?

- | | | |
|--|----|--------|
| a) through a central source in the DISTRICT | 47 | * (78) |
| b) through a central source in the SCHOOL | 57 | (79) |
| c) through a sharing arrangement between schools | 4 | (80) |
| d) I get my own | 39 | (81) |
| e) other (specify) _____ | | (82) |

12. How difficult is it to obtain science equipment when you need it?

- | | | |
|-----------------------------------|----|------|
| a) very difficult | 6 | |
| b) somewhat difficult | 37 | |
| c) not very difficult | 46 | |
| d) not difficult at all | 12 | (83) |

13. Where is most of the science equipment stored in your school?

- | | | |
|--|----|------|
| a) convenient central storage room | 37 | |
| b) inconvenient central storage room | 22 | |
| c) scattered throughout the school | 26 | |
| d) designated classrooms | 10 | |
| e) other (specify) _____ | 5 | (84) |

Reading Materials

14. How many DIFFERENT titles of science magazines or books (not textbooks) are usually available to your students in your science area/room/laboratory?

- | | | |
|---------------------------|----|------|
| a) none | 32 | |
| b) 1 - 5 | 48 | |
| c) 6 - 10 | 9 | |
| d) 11 - 15 | 2 | |
| e) more than 15 | 9 | (85) |

15. In your opinion how adequate are the science reading materials in your school library?

- | | | |
|---|----|------|
| a) very inadequate | 7 | |
| b) somewhat inadequate | 21 | |
| c) satisfactory | 53 | |
| d) very adequate | 19 | |
| e) there is no school library | 5 | (86) |

Attitude Toward Science Teaching

16. In your opinion, how worthwhile is the prescribed B.C. science program to the students you are presently teaching?

- | | |
|------------------------------------|----|
| a) very worthwhile | 21 |
| b) of some worth | 64 |
| c) of little worth | 11 |
| d) practically worthless | 4 |

(87)

17. If you had a choice, would you avoid teaching science altogether?

- | | |
|------------------------|----|
| a) yes | 11 |
| b) undecided | 13 |
| c) no | 77 |

(88)

18. If you had a choice, at which grade level would you prefer to teach science?

- | | |
|-----------------------------------|----|
| a) none | 6 |
| b) primary/kindergarten | 43 |
| c) intermediate | 48 |
| d) junior secondary | 2 |
| e) senior secondary | 1 |
| f) post-secondary | 0 |

(89)

19. As a rule, are you comfortable teaching science?

- | | |
|-------------------------|----|
| a) yes | 63 |
| b) no | 8 |
| c) in-between | 29 |
| d) no comment | 1 |

(90)

20. How do you feel about the demands made on you in implementing the new science curriculum?

- | | |
|--|----|
| a) I can't cope with it | 3 |
| b) Sometimes I find it too demanding | 21 |
| c) Generally I can cope | 51 |
| d) No problems in this area | 24 |

(91)

21. How important do you think elementary science should be in a child's elementary schooling?

- | | |
|--|----|
| a) more important than all other subjects | 0 |
| b) more important than most other subjects | 3 |
| c) equal to other subjects | 64 |
| d) less important than most other subjects | 33 |
| e) less important than all other subjects | 1 |

(92)

22. In your opinion, how do school and district administrators perceive the importance of elementary school science?

- | | |
|--|----|
| a) more important than all other subjects | 0 |
| b) more important than most other subjects | 1 |
| c) equal to other subjects | 49 |
| d) less important than most other subjects | 49 |
| e) less important than all other subjects | 1 |

(93)

Teaching Assignment

23. How many hours a week do you actually teach science?

- | | |
|------------------------------------|----|
| a) none | 2 |
| b) one half hour or less | 9 |
| c) 1 hour | 43 |
| d) 2 - 3 hours | 36 |
| e) 4 - 5 hours | 5 |
| f) 6 or more hours | 5 |

(94)

24. To how many different classes do you teach science?

- | | |
|--|----|
| a) none (another teacher takes my class for science) . . . | 3 |
| b) my own class only | 79 |
| c) two or three different classes | 16 |
| d) four or more different classes | 3 |

(95)

25. What kind of assistance are you given for cleaning up after science lessons, for preparing new lessons, for maintaining science equipment, etc?

- a) no assistance 51
- b) volunteer assistance from students 37
- c) volunteer assistance from parents 1
- d) paid student assistance 0
- e) paid adult assistance 1
- f) no assistance required 11

(11)

Teacher Education

Pre-Service

26. How adequately did your teacher education program prepare you for teaching Elementary Science as outlined in the new Interim Guide (1977)?

- a) very inadequately 35
- b) somewhat inadequately 33
- c) adequately 29
- d) very adequately 3

(12)

27. How much emphasis SHOULD be placed on each of the following in preparing student teachers to teach science? (Circle the appropriate number.)

	Minor Emphasis		Major Emphasis			
	1	2	3	4	5	
a) techniques of teaching science	1	3	19	28	50	(13)
b) subject matter in specific areas of science	4	10	36	28	22	(14)
c) general science	1	4	37	32	26	(15)
d) history and philosophy of science	39	35	20	4	2	(16)
e) psychology of learning	16	21	32	17	14	(17)
f) testing and evaluation in science	6	16	40	28	10	(18)
g) child psychology	17	22	34	15	12	(19)
h) theories of intellectual development	25	26	30	12	7	(20)
i) survey of available curriculum materials	3	8	31	36	23	(21)
j) how to develop curriculum materials	2	5	22	35	37	(22)
k) lesson planning	1	3	20	37	40	(23)
l) preparation of science materials	1	3	26	40	30	(24)
m) practice in teaching science	0	1	16	33	50	(25)
n) discussion of problems of science teaching	2	9	36	32	21	(26)
o) care and maintenance of equipment	5	18	47	20	9	(27)
p) laboratory safety	5	12	31	24	28	(28)
q) special education	19	27	41	9	3	(29)
r) other (specify)						(30)

37.7

In-Service

28. How much in-service education do you feel you require this year to do a good job teaching science?

a) none	13
b) 3 - 5 hours (one afternoon workshop)	40
c) several sessions of 3 - 5 hours	37
d) an intensive refresher course	10

(31)

29. (Multiple Response Item)

Which forms of in-service have you had and which forms do you feel are of value?

	Have Had	Of Value	
a) informal meetings with other science teachers . . .	48	55	*(32-33)
b) informal meetings with university science education instructors	14	21	
c) informal meetings with scientists	9	15	(34-35)
d) workshops presented by other teachers	61	67	(36-37)
e) workshops presented by university science education instructors	29	36	(38-39)
f) workshops presented by scientists	4	11	(40-41)
g) workshops presented by Ministry of Education officials	3	8	(42-43)
h) formal (credit) university courses in science . . .	31	30	(44-45)
i) formal (credit) university courses in science education	31	34	(46-47)
j) visits to other classrooms	28	48	(48-49)
k) other (specify) _____			(50-51)
			(52-53)

30. How effective is the science in-service education program provided in your school/district?

a) no science in-service program is provided	25
b) very ineffective	13
c) somewhat ineffective	27
d) fairly effective	32
e) very effective	3

(54)

31. Generally, how willing would you be to participate in an in-service education workshop in science during after school hours or on weekends?

a) definitely would not participate	4
b) probably would not participate	14
c) probably would participate	51
d) definitely would participate	21
e) cannot say	10

(55)

32. Generally, how willing would you be to participate in an in-service education workshop in science during school hours if release time were given?

a) definitely would not participate	1
b) probably would not participate	3
c) probably would participate	34
d) definitely would participate	59
e) cannot say	3

378

(56)

-13-

Science Budget

33. How much money has been allocated to the science program in your school this year?

- | | | |
|---|----|------|
| a) not enough to teach the program properly. | 15 | |
| b) enough to teach the program properly | 33 | |
| c) more than enough to teach the program properly | 2 | |
| d) I don't know | 49 | (57) |

Instructional Practices

34. About what per cent of your evaluation of students in science is based on each of the following?

	0%	1-20	21-40	41-60	61-80	81-100%	
	↓	↓	↓	↓	↓	↓	
a) teacher-made objective tests	23	21	21	18	10	8	(58)
b) standardized objective tests	81	11	4	2	1	1	(59)
c) subjective tests (essay, paragraphs, etc.	50	30	12	5	2	1	(60)
d) laboratory/experiment write-ups	48	27	15	6	3	1	(61)
e) individual work contracts	64	17	10	4	3	2	(62)
f) reports on topics in science	24	39	20	10	6	2	(63)
g) projects.	16	37	24	12	7	3	(64)
h) oral tests	44	27	11	8	6	5	(65)
i) student self-reports	61	20	9	6	3	2	(66)
j) anecdotal records of achievement.	33	30	15	10	6	6	(67)
k) general attitude in class	5	39	20	14	11	12	(68)
l) work habits.	6	44	20	13	9	8	(69)
m) other (specify: _____)	11	21	42	13	11	2	(70)

35. How often do you engage the students in your science class in each of the following activities? (Circle the appropriate number.)

SCALE:	1	2	3	4	5	6						
	Never	Rarely (once or twice during course)	Occasion- ally	About half the the time	Frequently	Very frequently (almost every class period)						
							1	2	3	4	5	6
a)	carrying out experiments from a set of instructions						11	21	42	13	11	2
b)	making up their own experiments						28	36	28	4	3	1
c)	discussing the possible errors in an experiment that has been completed						16	21	37	11	13	3
d)	listening to lectures						32	29	29	11	4	1
e)	making a graph from the data that the students get from an experiment						20	26	38	8	8	1
f)	applying information to new problem situations						8	19	42	17	13	2
g)	making guesses about the results of an experiment						5	11	37	19	24	4
h)	interpreting or explaining for themselves the results of an experiment						5	9	34	21	24	6
i)	classifying objects or events						3	10	35	22	25	6
j)	describing/reporting observations in their own words						2	5	27	24	32	10
k)	measuring in an experiment						8	15	40	19	17	2
l)	doing worksheets						21	27	34	12	6	1
m)	discussing results of an experiment with other students						8	16	36	19	17	5
n)	copying notes from the blackboard/overhead projector						32	23	33	9	4	0
o)	working on problems at the end of a section in a book						51	18	22	6	3	0
p)	memorizing scientific information						46	24	23	5	2	0
q)	doing investigations at home						14	28	44	9	5	5
r)	reading from textbooks						27	14	37	15	6	1
s)	doing research in the library						14	16	45	13	71	1

36. (Multiple Response Item)

What provisions are made in science in your class or school for individual differences?

a)	no special provisions	52	
b)	continuous progress	22	
c)	individualized instruction	18	
d)	learning assistance classes	7	
e)	ability grouping by classes	5	
f)	ability grouping within the class	24	
g)	other (specify): _____	380	
			* (90)
			(91)
			(92)
			(93)
			(94)
			(95)
			(96)

3 (10)

37. Compared to the present, would you like to see more, the same, or less of each of the following in science teaching? (Circle the appropriate number.)

	<u>less</u>	<u>same</u>	<u>more</u>	
a) provision of materials rather than textbooks for teaching science	5	36	59	(11)
b) integration of science with other subject areas	2	45	53	(12)
c) discovery learning	9	46	45	(13)
d) activity centred learning	4	46	51	(14)
e) alternate programs in science	9	51	40	(15)
f) locally developed programs	5	40	55	(16)
g) outdoor education	3	42	55	(17)
h) teaching of basic science concepts	2	60	38	(18)
i) teaching of science processes (e.g., classifying, controlling variables, measuring)	4	63	33	(19)
j) definition of core	18	54	29	(20)
k) background information for teachers	1	31	68	(21)
l) provincial learning assessment	34	55	10	(22)
m) district learning assessment	26	57	17	(23)
n) freedom for teacher to define course	11	59	30	(24)
o) teacher input into purchase of equipment	1	54	44	(25)
p) environmental education	1	41	59	(26)

Interim Elementary Science Program

38. (Multiple Response Item)

Which of the new programs is available to you in your school?

a) Materials based program	51	*(27)
b) STEM	77	(28)
c) Exploring Science	74	(29)
d) none of these	4	(30)
e) I don't know	4	(31)

39. Do you actually use one program or a combination?

a) one program exclusively	5	
b) one program supplemented by my own ideas	29	
c) a combination of programs	67	(32)

40. Who made the actual choice of this program in your area?

a) district supervisory personnel	17	
b) school principal	4	
c) advisory group of teachers and/or principals	36	
d) other (specify): _____	13	
e) I don't know	29	(33)

41. What was the main reason for this choice?

a) The program was thought to provide the best science education	29	
b) The program seemed most approachable for classroom teachers		
not trained in science	20	
c) The program was least expensive	1	
d) The program was most readily available	5	
e) Other (specify): _____	5	
f) I don't know	40	(34)

42. (Multiple Response Item)

How do you supplement the elementary science program selected for your grade level?

a) No opportunity to supplement	6	*(35)
b) No need to supplement	8	(36)
c) Extra reading	34	(37)
d) Extra content	41	(38)
e) Extra activities	76	(39)
f) Extra equipment	24	(40)

43. Are sufficient materials available to your classroom for teaching the selected program to your grade level?

a) Sufficient materials are available	49	
b) Insufficient materials are available	44	
c) No materials are available	3	
d) I don't know	3	(41)

44. What advice would you give to the Ministry about the new elementary science program?

a) Keep it generally as it is or with minor changes	30	
b) Keep it, but increase the choices available	28	
c) Keep it with modifications	21	
d) Modify it extensively	5	
e) Start again	4	
f) I don't know	12	(42)

45. Which of the three programs would you prefer for your grade level?
(Check only one.)

a) Materials based program	24	
b) STEM	24	
c) Exploring Science	31	
d) I don't know	21	(43)

46. (Multiple Response Item)

Why would you prefer the program specified in question 45?
If you did not select a program, go on to next question.

a) Materials readily available	37	*(44)
b) More readable	34	(45)
c) More relevant to students	54	(46)
d) Easier to teach	36	(47)
e) Easier to prepare	32	(48)
f) Better teacher's guide	24	(49)
g) Better balance between content and process	46	(50)
h) Right amount of activity	48	(51)
i) Right degree of structure	34	(52)
j) Suited to my background	31	(53)
k) Other (specify): _____		(54)

47. Which one of the new programs are you most familiar with?
(Check only one.)

- a) Materials based program 31
- b) STEM 31
- c) Exploring Science 31
- d) none 1

(55)

48. Please use the following categories to rate the program you selected in question 47. (Circle the appropriate number.)
If you did not select a program go on to the next question.

RATINGS FOR MATERIALS BASED PROGRAM

	N/A	1	2	3	4	5*	
a) availability of materials	0	14	16	39	23	9	(56)
b) readability of text	50	6	8	26	10	1	(57)
c) relevance to students	0	4	10	38	35	14	(58)
d) ease of teaching	1	9	15	48	21	6	(59)
e) ease of preparation	1	15	20	43	18	4	(60)
f) usefulness of teacher's guide	7	8	14	38	26	7	(61)
g) balance between content and process	2	11	13	44	22	8	(62)
h) amount of pupil activity	0	1	2	24	41	32	(63)
i) degree of structure	1	9	15	49	22	5	(64)
j) suitability to teacher's background	2	4	9	46	27	12	(65)
k) selection of content	2	6	14	47	25	6	(66)
l) interest of pupils	0	2	6	30	42	20	(67)
m) overall rating	0	2	12	41	37	7	(68)

*Rating Scale: Not Applicable = 0 Poor = 1 Satisfactory = 2-3-4
Excellent = 5

RATINGS FOR STEM PROGRAM

	<u>N/A</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
a) availability of materials	1	18	16	44	19	3
b) readability of text	4	3	7	42	32	13
c) relevance to students	0	2	6	44	36	11
d) ease of teaching	0	2	8	46	35	9
e) ease of preparation	0	4	15	47	27	7
f) usefulness of teacher's guide	4	2	8	35	35	17
g) balance between content and process	0	2	8	47	32	9
h) amount of pupil activity	0	2	8	38	40	12
i) degree of structure	0	1	9	56	29	6
j) suitability to teacher's background	0	2	5	47	36	10
k) selection of content	0	2	10	45	34	9
l) interest to pupils	0	2	9	34	42	13
m) overall rating	0	1	6	42	44	7

RATINGS FOR EXPLORING SCIENCE

	<u>N/A</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
a) availability of materials	2	13	15	48	18	4
b) readability of text	4	1	6	40	34	16
c) relevance to students	0	1	8	38	41	11
d) ease of teaching	0	1	7	46	43	10
e) ease of preparation	0	2	8	48	34	9
f) usefulness of teacher's guide	9	4	11	36	30	10
g) balance between content and process	0	3	10	44	35	7
h) amount of pupil activity	0	5	16	37	34	8
i) degree of structure	0	1	7	49	34	9
j) suitability to teacher's background	1	2	5	43	40	11
k) selection of content	0	1	9	42	36	12
l) interest to pupils	0	1	7	34	45	13
m) overall rating	0	2	6	36	51	6

49. How often do you or your students actually use the following?
(Circle the appropriate number.)

KEY:	1	2	3	4	5	
	Never	Rarely	Sometimes	Frequently	Constantly	
				1	2	3
				4	5	
a) STEM textbooks				41	15	26
b) <u>Exploring Science</u> textbooks				36	12	26
c) Materials based units				22	18	38
d) Materials Based Program Interim Guide				49	21	22
e) Elementary Science Interim Guide				35	22	34
f) Locally-developed units				33	21	32
g) Teacher-developed units				7	11	35
h) B.C.T.F. lesson aids				30	27	35
i) Other (specify): _____						

(70)

(71)

(72)

(73)

(74)

(75)

(76)

(77)

(78)

50. If you are responsible for science in grade 7, which course of action are you mainly following with respect to the new program?

a) omitting science	0
b) using materials from the old program	6
c) using locally developed material	2
d) using my own ideas	18
e) using Grade 6 materials	4
f) other (specify): _____	5
g) using materials based program	6
h) does not apply	58

(79-80)

51. How would each of the following changes be likely to effect the quality of science learning in your classroom? (Circle the appropriate number.)

4 (10)

KEY: The quality of learning would likely:

1	2	3	4	5
Improve Greatly	Improve Somewhat	Remain the Same	Deteriorate Somewhat	Deteriorate Seriously

	1	2	3	4	5	
a) more direct input by you into the purchase of equipment .	11	41	47	1	1	(11)
b) better quality of equipment	14	46	39	1	0	(12)
c) less responsibility for maintenance of equipment	5	11	74	8	2	(13)
d) smaller class size	37	34	28	1	1	(14)
e) provision of wider selection of printed materials (texts)	18	37	42	2	1	(15)
f) more leadership and coordination at school level	15	42	41	2	1	(16)
g) more leadership and coordination at district level	17	42	38	2	1	(17)
h) decreased emphasis on core	4	13	69	13	2	(18)
i) increased provision of in-service	27	57	15	1	0	(19)
j) more science books in library	15	50	34	1	0	(20)
k) more time to prepare and mark	40	38	38	1	1	(21)
l) fewer classes to teach	18	23	57	1	1	(22)
m) more convenient storage space for equipment	19	38	42	1	1	(23)
n) more university courses in science (taken by yourself)	15	49	34	1	0	(24)
o) higher priority placed on science by administration	6	34	57	3	1	(25)
p) less in-service education	1	1	41	47	10	(26)
q) more time allocated to science	7	44	47	2	0	(27)
r) less time allocated to science	1	1	35	53	10	(28)
s) changes in the new program	0	31	61	5	1	(29)
t) increased availability of equipment and materials	28	51	20	1	1	(30)
u) fewer subjects/levels to teach	23	40	35	1	0	(31)
v) increased emphasis on core	3	16	64	15	3	(32)
w) more choice for teacher in selection of program	11	32	52	4	1	(33)

52. (Multiple response item)

Which of the following items do you keep in your classroom throughout the school year?

a)	live animals	24	*(34)
b)	fish	20	(35)
c)	thermometers	56	(36)
d)	globe	64	(37)
e)	batteries	16	(38)
f)	equal arm or pegboard balances	29	(39)
g)	spring scales	18	(40)
h)	hand lenses	36	(41)
i)	magnets	37	(42)
j)	magnetic compasses	13	(43)
k)	plasticene	60	(44)
l)	flashlights	9	(45)
m)	mirrors	28	(46)
n)	balloons	25	(47)
c)	plants	62	(48)
p)	seeds	33	(49)
q)	candles	23	(50)
r)	rocks	38	(51)
s)	barometer	9	(52)
t)	alcohol burners	7	(53)
u)	hot plate	12	(54)
v)	clock with second hand	58	(55)

53. (Multiple response item)

Which of the following items have you had in your classroom at some time this school year?

a)	live animals	54	*(56)
b)	fish	24	(57)
c)	thermometers	67	(58)
d)	globe	72	(59)
e)	batteries	34	(60)
f)	equal arm or pegboard balances	40	(61)
g)	spring scales	38	(62)
h)	hand lenses	59	(63)
i)	magnets	59	(64)
j)	magnetic compasses	36	(65)
k)	plasticene	61	(66)
l)	flashlights	41	(67)
m)	mirrors	47	(68)
n)	balloons	53	(69)
o)	plants	70	(70)
p)	seeds	62	(71)
q)	candles	45	(72)
r)	rocks	60	(73)
s)	barometer	16	(74)
t)	alcohol burners	14	(75)
u)	hot plate	30	(76)
v)	clock with second hand	58	(77)

Comments

Please use this page for more detailed comments.

(78)

The comments noted on this last page of each of the three levels of Teacher Questionnaires are summarized in Appendix B - Teachers' Written Comments on Questionnaires.

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School Code

DO NOT IDENTIFY YOURSELF ANYWHERE IN THE BOOKLET

Strict Confidentiality will be Maintained

BRITISH COLUMBIA LEARNING ASSESSMENT PROGRAM

JUNIOR SECONDARY SCIENCE

A TEACHER QUESTIONNAIRE

We appreciate the fact that school programs at the present time are so varied that the questions posed here may not fit your school organization or philosophy. Where there is a lack of 'fit' between our questions and your organization or philosophy, please specify and comment. Use the last page for more detailed comment. In general, we would ask that you respond as fully as you can.

The purpose of the questionnaire is to provide useful information for curriculum revision, for research and for improving the teaching and learning of science.

Note: Please check or circle the appropriate response for each item. On some items, more than one choice may be marked. Such items will be preceded by '(Multiple Response Item)'. All other items are to be responded to only once.

IMPORTANT

1 (10)

On the label on the envelope in which you received this questionnaire is marked a grade/year level corresponding to one of those below. Please check the appropriate box and respond to the questionnaire with this one level in mind, even though you may also teach other levels.

Science Grade 8 . .	☐	1
Science Grade 9 . .	☐	2
Science Grade 10 . .	☐	3

(11)

Background and General Information

I. Years of teaching experience as of June 1978:

a) 1 or less	6
b) 2 - 5	30
c) 6 - 9	24
d) 10 - 13	15
e) 14 or more	25

(12)

II. Are you male or female?

a) male	88
b) female	12

(13)

III. How many courses in methods of teaching science have you taken?

a) none	13
b) one	35
c) major/concentration in science education	44
d) other (specify) _____	9

(14)

IV. When did you take your MOST RECENT course in methods of teaching science?

19 __ __

(15-16)

V. How old are you?

a) under 20 years	2
b) 20 - 24	28
c) 25 - 29	28
d) 30 - 34	16
e) 35 - 39	16
f) 40 - 49	8
g) 50 - 59	2
h) 60 and over	0

(17-18)

VI. How many students are in your largest science class this year?

a) 20 or less	4
b) 21 - 24	8
c) 25 - 28	25
d) 29 - 32	51
e) Over 32	13

(19)

VII. How many college/university courses have you had in each of the following areas of science?

	0	1-3	4-7	8 or more	
a) Biology	14	31	23	32	(20)
b) Chemistry	5	55	27	13	(21)
c) Physics	14	60	17	9	(22)
d) Astronomy	81	18	1	0	(23)
e) Earth Science	39	50	5	6	(24)
f) General Science	49	45	4	2	(25)

VIII. (Multiple Response Item)

Which science courses have you taught so far?
(Check more than one if appropriate)

	This Year	Previous Years	
a) Elementary science, kindergarten/primary	0	3	*(26-27)
b) Elementary science, intermediate . .	2	17	(28-29)
c) Science 8	65	73	(30-31)
d) Science 9	68	69	(32-33)
e) Science 10	40	61	(34-35)
f) Biology 11	11	24	(36-37)
g) Biology 12	7	15	(38-39)
h) Chemistry 11	10	20	(40-41)
i) Chemistry 12	6	12	(42-43)
j) Physics 11	6	12	(44-45)
k) Physics 12	3	7	(46-47)
l) Earth Science 11	3	3	(48-49)
m) Geology 12	0	1	(50-51)
n) Special electives	4	6	(52-53)
o) Other (specify): _____ . .			(54-55)

IX. How much of your teaching time do you spend as a science teacher?

a) full-time science	46	
b) part-time science, part-time math . .	29	
c) part-time science, part-time in one other non-math subject area	12	
d) part-time science, part-time in two or more other subject areas	10	
e) part-time science, part-time counselling and/or administration	3	

392

(56)

Leadership

143

1. With reference to the secondary science program in your SCHOOL:
Which of the following best describes the form of leadership which exists?

- a) There is a specially designated science coordinator or department head who is responsible for just the secondary grades 63
- b) There is a specially designated science coordinator or department head who is responsible for elementary and secondary grades 2
- c) There is a specially designated coordinator or department head who is responsible for science and one or more other subjects 10
- d) Leadership and coordination are performed by a working group of teachers in the school 13
- e) Leadership and coordination have been assumed by the principal vice-principal or one of the teachers 3
- f) There is no particular form of leadership 8
- g) Other (specify): _____ 2

(57)

2. In general terms, how do you rate this form of leadership?

- a) Excellent 16
- b) Very good 35
- c) Satisfactory 45
- d) Unsatisfactory 7
- e) Very unsatisfactory 1

(58)

3. With reference to the secondary science program in your DISTRICT:
Which of the following best describes the form of leadership which exists?

- a) There is a specially designated science coordinator or supervisor responsible for just the secondary grades 10
- b) There is a specially designated science coordinator or supervisor who is responsible for elementary and secondary grades 2
- c) There is a specially designated coordinator or supervisor who is responsible for science and one or more other subjects 7
- d) Leadership and coordination are performed by a working group of teachers in the district 17
- e) Leadership and coordination have been assumed by one of the administrators or teachers in the district 4
- f) There is no particular form of leadership 57
- g) Other (specify): _____ 3

(59)

4. In general terms, how do you rate this form of leadership?

- a) Excellent 5
- b) Very good 9
- c) Satisfactory 41
- d) Unsatisfactory 32
- e) Very unsatisfactory 14

(60)

Physical Facilities

5. How adequate are the following physical facilities for teaching science in your school? (Circle the appropriate number.)

	Not Needed	Very Inadequate				Excellent	
	0	1	2	3	4	5	
a) tables/counters		6	11	31	33	19	(61)
b) lighting		2	3	23	41	30	(62)
c) storage space for science materials/ equipment		11	19	27	25	18	(63)
d) amount of work space per student .		9	19	34	27	11	(64)
e) growing room/preparation room . .		25	18	23	19	15	(65)
f) storage space for student projects .		36	26	21	10	6	(66)
g) audio-visual equipment		4	10	33	37	15	(67)
h) storage space for acids		15	14	27	28	15	(68)
i) storage space for volatiles		19	16	25	24	15	(69)
j) gas outlets		7	8	26	33	27	(70)
k) water outlets		11	12	27	28	22	(71)
l) electrical outlets		5	10	23	34	28	(72)
m) sinks or drainage facilities . . .		9	13	25	32	22	(73)
n) fume hood/closet		24	10	24	22	15	(74)
o) safety equipment		7	19	37	28	9	(75)

Safety

6. How systematically is the safety equipment checked in your science area/room/laboratory?

a) no safety equipment	2	
b) casually, at best	36	
c) systematically; once a year	46	
d) systematically; more than once a year . .	17	(76)

7. (Multiple Response Item)

What safety equipment do you have in your science teaching area/room/laboratory?

a) none	1	* (77)
b) fire blankets	54	(78)
c) fire extinguisher	94	(79)
d) master gas shut-off	88	(80)
e) master water shut-off	28	(81)
f) approved first aid kit	52	(82)
g) safety goggles	56	(83)
h) asbestos gloves	17	(84)
i) sand buckets and scoops	12	(85)
j) eye wash stations	74	(86)
k) other (specify): _____		(87)

Equipment/Materials

8. Apart from minor changes, how often have you had to adapt your teaching plans this year because of difficulty in obtaining the necessary science equipment?

- | | |
|--|----|
| a) never | 16 |
| b) seldom; about once or twice | 53 |
| c) fairly often; about three or four times | 18 |
| d) quite often; about five or six times | 7 |
| e) far too often; more than six times | 7 |
| f) I seldom plan to use equipment | 1 |

(88)

9. Overall, how do you rate the quality of the science equipment available to you?

- | | |
|------------------------|----|
| a) excellent | 15 |
| b) good | 59 |
| c) tolerable | 22 |
| d) poor | 3 |
| e) very poor | 1 |

(89)

10. How much input do you have in deciding what science materials/equipment are to be purchased?

- | | |
|--------------------------------------|----|
| a) none | 4 |
| b) not nearly enough input | 9 |
| c) about right | 87 |

(90)

11. Who maintains and accounts for the science equipment in your school?

- | | |
|---|----|
| a) each science teacher looks after his/her own equipment | 23 |
| b) each science teacher looks after certain equipment | 10 |
| c) a specially designated science teacher | 9 |
| d) head of science department | 37 |
| e) paid assistants | 15 |
| f) nobody takes any responsibility | 2 |
| g) other (specify): _____ | 5 |

(91)

12. How difficult is it to obtain science equipment when you need it?

a) very difficult	3
b) somewhat difficult	26
c) not very difficult	47
d) not difficult at all	25

(92)

Reading Materials

13. How many DIFFERENT titles of science magazines or books (not textbooks) are usually available to your students in your science area/room/laboratory?

a) none	32
b) 1 - 5	56
c) 6 - 10	5
d) 11 - 15	2
e) more than 15	4

(93)

14. In your opinion how adequate are the science reading materials in your school library?

a) very inadequate	5
b) somewhat inadequate	19
c) satisfactory	50
d) very adequate	25
e) there is no school library	0

(94)

Attitude Toward Science Teaching

15. In your opinion, how worthwhile is the prescribed B.C. science program to the students you are presently teaching?

(95)

16. If you had a choice, would you avoid teaching science altogether?

(96)

17. If you had a choice, at which grade level would you prefer to teach science?

(97)

18. As a rule, are you comfortable teaching science?

(98)

19. How important do you think Junior Secondary science should be in a student's schooling?

- | | |
|--|----|
| a) more important than all other subjects | 1 |
| b) more important than most other subjects | 18 |
| c) equal to other subjects | 80 |
| d) less important than most other subjects | 1 |
| e) less important than all other subjects | 0 |

(99)

20. In your opinion, how important do school and district administrators think Junior Secondary science should be in a student's schooling?

- | | |
|--|----|
| a) more important than all other subjects | 0 |
| b) more important than most other subjects | 7 |
| c) equal to other subjects | 81 |
| d) less important than most other subjects | 11 |
| e) less important than all other subjects | 0 |

(100)

Teaching Load

21. What fraction of your teaching load this year is in science?

- | | |
|--|----|
| a) full load | 46 |
| b) more than half, but not a full load | 26 |
| c) half load | 8 |
| d) less than half load | 21 |

(101)

Preparation for Teaching

22. How many hours per week, on the average, are you given DURING SCHOOL HOURS for preparation and marking for your science classes?

a)	no time during school hours	6
b)	less than 1 hour.	11
c)	1 - 2 hours	28
d)	3 - 4 hours	48
e)	more than four hours.	8

(102)

23. How many hours per week, on the average, do you need to prepare and mark for your science classes?

a)	less than 1 hour.	0
b)	1 - 2 hours	7
c)	3 - 4 hours	20
d)	5 - 6 hours	24
e)	more than 6 hours	49

(103)

Marking Load

24. How do you handle the marking of students' lab write-ups?

a)	I don't mark any write-ups	2
b)	I mark all write-ups.	59
c)	I mark write-ups for a sample of the students for each experiment	2
d)	I mark each student's write-up for a sample of experiments	33
e)	I mark a sample of students' write-ups for a sample of experiments	3

(104)

25. What proportion of the lab/experiment write-ups that you mark receive detailed comments?

a)	none.	5
b)	very few; well below half	37
c)	few; about half	29
d)	quite a few; well over half	21
e)	all	8

(105)

26. Overall, how manageable is your marking load in science?

a)	unmanageable.	10
b)	barely manageable	47
c)	quite manageable.	43

(106)

399

Teacher Education

Pre-Service

29. How adequately did your pre-service teacher education program in science prepare you for teaching science?

- | | |
|--|----|
| a) very inadequately | 15 |
| b) somewhat inadequately | 32 |
| c) adequately | 33 |
| d) very adequately | 11 |
| e) I had no teacher education in science | 8 |

(22)

30. How much emphasis SHOULD be placed on each of the following in preparing student teachers to teach science? (Circle the appropriate number).

	Minor Emphasis				Major Emphasis		
	1	2	3	4	5		
a) how to teach science	2	4	15	30	50	(23)	
b) subject matter in specific areas of science	6	7	26	31	30	(24)	
c) general science	4	8	35	32	21	(25)	
d) history and philosophy of science	26	35	26	9	3	(26)	
e) psychology of learning	13	18	31	25	12	(27)	
f) testing and evaluation in science	3	8	34	37	18	(28)	
g) psychology of adolescence	12	19	35	24	10	(29)	
h) theories of intellectual development	24	32	29	11	4	(30)	
i) survey of available curriculum materials	4	12	30	34	20	(31)	
j) how to develop curriculum materials	5	10	28	36	21	(32)	
k) lesson planning	2	7	24	38	28	(33)	
l) preparation of science materials	1	5	24	44	26	(34)	
m) practice in teaching science	0	2	8	22	68	(35)	
n) discussion of problems of science teaching	1	7	24	36	33	(36)	
o) care and maintenance of equipment	7	15	43	24	12	(37)	
p) laboratory safety	3	11	26	28	33	(38)	
q) special education	15	26	36	17	6	(39)	
r) other (specify): <u>401</u>						(40)	

In-Service

31. How much in-service education do you feel you require this year to do a good job teaching science?

- | | |
|---|----|
| a) none | 22 |
| b) 3 - 5 hours (one afternoon workshop) | 32 |
| c) several sessions of 3 - 5 hours | 39 |
| d) an intensive refresher course. | 7 |

(41)

32. (Multiple Response Item)

Which forms of in-service have you had and which forms do you feel are of value?

- | | Have
Had | Of
Value | |
|---|-------------|-------------|----------|
| a) informal meetings with other science teachers. | 85 | 84 | *(42-43) |
| b) informal meetings with university science education
instructors | 31 | 33 | (44-45) |
| c) informal meetings with scientists | 21 | 31 | (46-47) |
| d) workshops presented by other teachers. | 66 | 66 | (48-49) |
| e) workshops presented by university science education
instructors | 41 | 42 | (50-51) |
| f) workshops presented by scientists. | 21 | 31 | (52-53) |
| g) workshops presented by Ministry of Education officials | 9 | 9 | (54-55) |
| h) formal (credit) university courses in science. | 35 | 41 | (56-57) |
| i) formal (credit) university courses in science education | 28 | 31 | (58-59) |
| j) visits to other classrooms | 41 | 52 | (60-61) |
| k) other (specify) _____ | | | (62-63) |

33. How effective is the science in-service education program provided in your school/district?

- | | |
|---|----|
| a) no science in-service program is provided. | 39 |
| b) very ineffective | 19 |
| c) somewhat ineffective | 27 |
| d) fairly effective | 14 |
| e) very effective | 1 |

(64)

34. Generally, how willing would you be to participate in an in-service education workshop in science during after school hours or on weekends?

- | | |
|---|----|
| a) definitely would not participate | 3 |
| b) probably would not participate | 14 |
| c) probably would participate | 51 |
| d) definitely would participate | 24 |
| e) cannot say | 8 |

(65)

35. Generally, how willing would you be to participate in an in-service education workshop in science during school hours if release time were given?

- | | |
|---|----|
| a) definitely would not participate | 1 |
| b) probably would not participate | 4 |
| c) probably would participate | 37 |
| d) definitely would participate | 55 |
| e) cannot say | 4 |

(66)

Science Budget

36. How much money has been allocated to the science program in your school this year?

- | | |
|---|----|
| a) not enough to teach the program properly | 12 |
| b) enough to teach the program properly | 69 |
| c) more than enough to teach the program properly | 4 |
| d) I don't know | 15 |

(67)

Instructional Practices

37. About what per cent of your evaluation of students in science is based on each of the following?

	0%	1-20	21-40	41-60	61-80	81-100%	
	↓	↓	↓	↓	↓	↓	
a) teacher-made objective tests	0	11	34	39	13	3	(68)
b) standardized objective tests	82	12	5	1	1	0	(69)
c) subjective tests (essay, paragraphs, etc.)	20	57	17	4	1	0	(70)
d) laboratory/experiment write-ups	1	21	47	26	4	1	(71)
e) individual work contracts	79	19	3	0	0	0	(72)
f) reports on topics in science	28	66	6	0	0	0	(73)
g) projects	35	39	6	1	0	0	(74)
h) oral tests.	74	24	2	0	0	0	(75)
i) student self-reports	85	14	2	0	0	0	(76)
j) anecdotal records of achievement	74	22	2	1	0	0	(77)
k) general attitude in class	29	65	5	1	0	0	(78)
l) work habits	21	69	6	2	1	0	(79)
m) other (specify: _____)							(80)

38. How often do you engage the students in your science classes in each of the following activities? (Circle the appropriate number).

SCALE:	1	2	3	4	5	6	
	Never	Rarely (once or twice during course)	Occasion- ally	About half of the time	Frequently	Very Frequently (almost every class period)	
	1	2	3	4	5	6	
a) carrying out experiments from a set of instructions	0	2	10	25	46	17	(81)
b) making up their own experiments	38	50	11	0	0	0	(82)
c) discussing the possible errors in an experiment that has been completed	2	12	39	19	23	5	(83)
d) listening to lectures	6	22	54	14	4	1	(84)
e) making a graph from the data that the students get from an experiment	5	25	52	8	9	1	(85)
f) applying information to new problem situations	3	15	49	19	13	2	(86)
g) making guesses about the results of an experiment	2	17	45	18	15	2	(87)
h) interpreting or explaining for themselves the results of an experiment.	1	8	27	28	28	8	(88)
i) classifying objects or events	10	29	41	13	6	2	(89)
j) describing/reporting observations in their own words.	1	6	21	19	39	14	(90)
k) measuring in an experiment	1	4	24	27	37	8	(91)
l) doing worksheets.	6	23	49	13	8	1	(92)
m) discussing results of an experiment with other students.	5	14	34	19	22	6	(93)
n) copying notes from the blackboard/overhead projector.	3	16	57	16	8	1	(94)
o) working on problems at the end of a section in a book	5	15	43	15	18	4	(95)
p) memorizing scientific information	9	33	44	10	4	1	(96)
q) doing investigations at home.	25	58	15	1	0	0	(97)
r) reading from textbooks	3	19	57	13	7	2	(98)
s) doing research in the library	0	14	42	39	4	2	(99)

39. (Multiple Response Item)

What provisions are made in science in your class or school for individual differences?

a) no special provisions	29	(100)
b) continuous progress.	14	(101)
c) individualized instruction	18	(102)
d) learning assistance classes.	40	(103)
e) ability grouping by classes.	38	(104)
f) ability grouping within the class	14	(105)
g) other (specify): _____	404	(106)

3 (10)

40. Compared to the present, would you like to see more, the same, or less of each of the following in science teaching? (Circle the appropriate number).

	<u>less</u>	<u>same</u>	<u>more</u>	
a) provision by Ministry of materials for teaching science	6	35	59	(11)
b) provision by District of materials for teaching science	2	34	64	(12)
c) integration of science with other subject areas	4	48	48	(13)
d) discovery learning	22	58	21	(14)
e) activity centred learning	6	67	28	(15)
f) provincially developed alternates to present programs	8	29	63	(16)
g) locally developed programs	6	40	54	(17)
h) outdoor education	6	41	53	(18)
i) teaching of basic science concepts	1	58	41	(19)
j) teaching of science processes (e.g., classifying, controlling variables, measuring)	2	65	33	(20)
k) definition of core	15	56	29	(21)
l) background information for teachers	1	31	68	(22)
m) provincial learning assessment	19	62	18	(23)
n) district learning assessment	14	61	25	(24)
o) freedom for teacher to define course	11	63	27	(25)
p) teacher input into purchase of equipment	0	70	30	(26)
q) environmental education	3	42	55	(27)

41. On the average, what percent of your science students receive a passing grade over the year?

a) 100%	0	
b) 95-99%	16	
c) 90-94%	33	
d) 80-89%	42	
e) fewer than 80%	9	(28)

42. (Multiple Response Item)

Which of the following special science programs exist in your school?

- | | | |
|---|----|--------|
| a) terminal science courses for students who are leaving school in junior high years | 35 | * (29) |
| b) special learning assistance science courses for low achievers | 41 | (30) |
| c) technology-oriented science courses | 11 | (31) |
| d) recreation science courses (either courses or extra-curricular clubs -- lapidary, science photography, nature study) | 21 | (32) |
| e) special electives or sections for advanced students | 19 | (33) |
| f) other (specify): _____ | | (34) |

43. Which time-table pattern does your school have?

- | | | |
|-------------------------------------|----|------|
| a) quarter | 11 | |
| b) semester | 38 | |
| c) regular full year | 46 | |
| d) other (specify): _____ | 5 | (35) |

44. Which time-table pattern would you prefer?

- | | | |
|-------------------------------------|----|------|
| a) quarter | 10 | |
| b) semester | 35 | |
| c) regular full year | 51 | |
| d) other (specify): _____ | 4 | (36) |

45. Do you have enough time to cover the science courses?

- | | | |
|------------------------------------|----|------|
| a) more than enough time | 3 | |
| b) enough time | 35 | |
| c) almost enough time | 26 | |
| d) not enough time | 37 | (37) |

Texts and Readers

46. How does the revised Grade 8 science text by Schmid et al compare with the previous edition by Schmid et al?

a)	it is considerably better	30
b)	it is somewhat better	32
c)	it is much the same	10
d)	it is not as good	3
e)	it is considerably worse	1
f)	not familiar with these books	25

(38)

47. (Multiple Response Item)

Which of the following changes are desirable in the Grades 9 and 10 lab texts (Developing, and Extending Science Concepts in the Laboratory)?

a)	more coloured photographs to illustrate procedure	39
b)	more line drawings to illustrate procedure	44
c)	more detail describing procedure	27
d)	more questions at the end of the chapter	43
e)	more questions at the end of each lab	33
f)	more of an 'open-ended' discovery approach	19
g)	more related background reading	72
h)	more challenging experiments for brighter students	41
i)	more easy experiments for less able students	58
j)	more summary notes and questions	60
k)	more flexibility	21
l)	more structure and sequence	26
m)	no changes are necessary	2
n)	other (specify):	10
o)	not familiar with these books	5

*(39)
(40)
(41)
(42)
(43)
(44)
(45)
(46)
(47)
(48)
(49)
(50)
(51)
(52)
(53)

48. (Multiple Response Item)

How suitable are the background reading materials (the Reading About Science series)?

a)	too difficult	50
b)	not related to lab topics	60
c)	generally satisfactory	22
d)	not current	12
e)	not familiar with these books	1

*(54)
(55)
(56)
(57)
(58)

49. How do you usually use the Reading About Science series?
(Check one only)

a)	never use them	11
b)	make them available to students to read as they wish	7
c)	recommend certain readings without follow-up	17
d)	assign readings to discuss in class	51
e)	assign readings to test in class	14

(59)

50. About how many hours is usually spent by your classes on each of the following sections of junior high school?

	0-9	10-19	20-29	30-39	40-49	50+	
	↓	↓	↓	↓	↓	↓	
A. Grade 8: Earth Science	18	24	40	14	4	1	(60)
Biology	2	9	51	30	7	2	(61)
Chemistry	1	6	47	35	10	2	(62)
Optics.	3	11	50	27	8	1	(63)
Measurement	48	36	14	2	0	0	(64)
Have not taught Grade 8							(65)
B. Grade 9: Chemistry - Atoms and Chemical Change	1	4	44	35	12	4	(66)
Forces and Energy	5	18	47	22	6	1	(67)
Heat Energy	18	31	38	10	3	1	(68)
Space Science	36	25	27	9	2	1	(69)
Biology - Living Things Require Energy	1	9	50	29	9	4	(70)
Have not taught Grade 9							(71)
C. Grade 10: Radioactivity	8	8	2	0	0	0	(72)
Electricity and Magnetism	6	21	44	22	7	2	(73)
Atoms, Molecules and Ions	2	12	42	31	10	3	(74)
The Planet Earth (Earth Science)	37	29	27	5	2	1	(75)
Cells Reproduction and Heredity	0	6	30	42	16	7	(76)
Sound and Wave Motion	40	38	17	3	2	0	(77)
Have not taught Grade 10							(78)

51. How useful do you find the following materials? (Circle the appropriate number).

	Can- not Say	Of Little Use	Useful	Very Useful	
a) Labtext in Science (Cannon <u>et al</u>)	26	31	32	11	(79)
b) Mixtures in Chemistry (Harrison, Murphy)	54	20	23	4	(80)
c) Ecology: Field Research in Science (Jacobson <u>et al</u>)	63	16	19	3	(81)
d) Investigations in Science Modules (Wiley Series)	84	8	8	1	(82)
e) B.C.T.F. lesson aids	30	25	41	4	(83)
f) locally developed units	54	12	23	10	(84)
g) Searching for Structure series	87	6	6	1	(85)
h) I.S.C.S.	72	10	15	4	(86)
i) I.I.S. (Wong <u>et al</u>)	79	10	9	2	(87)
j) other (specify): _____					(88)

Self Rating

52. How would you rate your teaching performance in science?

a) poor	0	
b) below average.	2	
c) average	21	
d) good	57	
e) excellent.	15	
f) no comment	6	(89)

Student Attitudes

53. How has student interest and motivation in learning science at school changed over the last four or five years?

a) no opinion	20	
b) cannot notice any change	36	
c) motivation seems to have increased	19	
d) motivation seems to have decreased	24	(90)

Effectiveness of Teaching

54. How would each of the following changes be likely to effect the quality of science learning in your classroom? (Circle the appropriate number).

KEY: The quality of learning would likely:

	1 Improve Greatly	2 Improve Somewhat	3 Remain the Same	4 Deteriorate Somewhat	5 Deteriorate Seriously	
	1	2	3	4	5	
a) more direct input by you into the purchase of equipment .	5	22	67	1	1	(91)
b) better quality of equipment	8	50	41	1	0	(92)
c) less responsibility for maintenance of equipment	4	21	55	16	4	(93)
d) smaller class size	45	42	11	1	0	(94)
e) provision of wider selection of printed materials (texts).	34	53	13	1	0	(95)
f) more leadership and coordination at school level	5	31	61	2	0	(96)
g) more leadership and coordination at district level	8	38	49	5	1	(97)
h) decreased emphasis on core	3	11	64	18	4	(98)
i) increased provision of in-service	13	60	26	0	0	(99)
j) more science books in the library	8	51	41	0	0	(100)
k) more time for preparation and marking.	30	53	16	0	0	(101)
l) fewer classes to teach	26	45	28	0	0	(102)
m) more convenient storage space for equipment	11	34	54	0	0	(103)
n) more university courses in science (taken by yourself)	9	47	43	0	0	(104)
o) higher priority placed on science by administration	4	31	65	1	0	(105)
p) less in-service education	0	2	50	43	5	(106)
q) more time allocated to science	6	48	43	3	0	(107)
r) less time allocated to science	0	1	26	58	15	(108)
s) complete revision of junior high program	23	42	31	4	1	(109)
t) increased availability of equipment and materials	12	56	31	0	1	(110)
u) fewer subjects/levels to teach	15	40	43	2	0	(111)
v) increased emphasis on core	4	17	59	18	30	(112)

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TQSR

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School Code

DO NOT IDENTIFY YOURSELF ANYWHERE IN THIS BOOKLET
Strict Confidentiality Will Be Maintained

BRITISH COLUMBIA LEARNING ASSESSMENT PROGRAM

SENIOR SECONDARY SCIENCE

A TEACHER QUESTIONNAIRE

We appreciate the fact that school programs at the present time are so varied that the questions posed here may not fit your school organization or philosophy. Where there is a lack of 'fit' between our questions and your organization or philosophy, please specify and comment. Use the last page for more detailed comment. In general, we would ask that you respond as fully as you can.

The purpose of the questionnaire is to provide useful information for Curriculum revision, for research and for improving the teaching and learning of science.

Note: Please check or circle the appropriate response for each item. For some items, more than one choice may be marked. These items will be identified as multiple response items. All other items are to be responded to only once.

IMPORTANT

On the label on the envelope in which you received this questionnaire is marked a grade/year level corresponding to one of those below. Please check the appropriate box and respond to the questionnaire with this one level in mind, even though you may also teach other levels.

- | | | |
|--|--------------------------|---|
| Biology 11 | ☐ | 1 |
| Biology 12 | ☐ | 2 |
| Chemistry 11 | ☐ | 3 |
| Chemistry 12 | ☐ | 4 |
| Physics 11 | ☐ | 5 |
| Physics 12 | ☐ | 6 |
| Earth Science/
Geology 11, 12 | ☐ | 7 |

1 (10)

(11)

Background and General Information

I. Years of teaching experience as of June 1978:

a) 1 or less	2
b) 2 - 5	15
c) 6 - 9	20
d) 10 - 13	23
e) 14 or more.	40

(12)

II. Are you male or female?

a) male	94
b) female.	6

(13)

III. How many courses in methods of teaching science have you taken?

a) none	6
b) one	37
c) major/concentration in science education	48
d) other (specify) _____	9

(14)

IV. When did you take your MOST RECENT course in methods of teaching science?

19__

(15-16)

V. How old are you?

a) under 20 years.	0
b) 20 - 24	2
c) 25 - 29	10
d) 30 - 34	23
e) 35 - 39	25
f) 40 - 49	25
g) 50 - 59	13
h) 60 and over	2

(17-18)

VI. How many students are in your largest science class this year?

a) 20 or less.	15
b) 21 - 24	27
c) 25 - 28	34
d) 20 - 32	21
e) Over 32	4

(19)

VII. How many college/university courses have you had in each of the following areas of science?

	0	1-3	4-7	8 or more	
a) Biology	16	32	16	36	(20)
b) Chemistry	20	50	31	17	(21)
c) Physics	9	54	22	15	(22)
d) Astronomy	82	18	0	0	(23)
e) Earth Science	37	55	5	4	(24)
f) General Science	60	34	5	3	(25)

VIII. (Multiple Response Item)

Which science courses have you taught so far?
(Check more than one if appropriate.)

	This Year	Previous Years	
a) Elementary science, kindergarten/primary.	0	2	*(26-27)
b) Elementary science, intermediate.	0	13	(28-29)
c) Science 8	13	59	(30-31)
d) Science 9	20	63	(32-33)
e) Science 10	31	75	(34-35)
f) Biology 11	38	37	(36-37)
g) Biology 12	32	27	(38-39)
h) Chemistry 11.	34	37	(40-41)
i) Chemistry 12.	26	23	(42-43)
j) Physics 11	27	31	(44-45)
k) Physics 12	18	21	(46-47)
l) Earth Science 11	9	42	(48-49)
m) Geology 12	2	1	(50-51)
n) Special electives	4	5	(52-53)
o) Other (specify): _____			(54-55)

IX. How much of your teaching time do you spend as a science teacher?

a) full-time science	59	
b) part-time science, part-time math	25	
c) part-time science, part-time in one other non-math subject area	6	
d) part-time science, part-time in two or more other subject areas	5	
e) part-time science, part-time counselling and/or administration	5	(56)

Leadership

1. With reference to the secondary science program in your SCHOOL:
Which of the following best describes the form of leadership
which exists?

- a) There is a specially designated science coordinator or department head who is responsible for just the secondary grades 66
- b) There is a specially designated science coordinator or department head who is responsible for elementary and secondary grades 0
- c) There is a specially designated coordinator or department head who is responsible for science and one or more other subjects 14
- d) Leadership and coordination are performed by a working group of teachers in the school 10
- e) Leadership and coordination have been assumed by the principal, vice-principal or one of the teachers 1
- f) There is no particular form of leadership 7
- g) Other (specify): _____ 2

(57)

2. In general terms, how do you rate this form of leadership?

- a) Excellent 19
- b) Very good 36
- c) Satisfactory 39
- d) Unsatisfactory 5
- e) Very unsatisfactory 2

(58)

3. With reference to the secondary science program in your DISTRICT:
Which of the following best describes the form of leadership
which exists?

- a) There is a specially designated science coordinator or supervisor responsible for just the secondary grades 9
- b) There is a specially designated science coordinator or supervisor who is responsible for elementary and secondary grades 4
- c) There is a specially designated coordinator or supervisor who is responsible for science and one or more other subjects 10
- d) Leadership and coordination are performed by a working group of teachers in the district 16
- e) Leadership and coordination have been assumed by one of the administrators or teachers in the district 2
- f) There is no particular form of leadership 56
- g) Other (specify): _____ 3

(59)

4. In general terms, how do you rate this form of leadership?

- a) Excellent 3
- b) Very good 8
- c) Satisfactory 44
- d) Unsatisfactory 33
- e) Very unsatisfactory 12

(60)

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Physical Facilities

5. How adequate are the following physical facilities for teaching science in your school? (Circle the appropriate number.)

	Not Needed	Very Inadequate			Excellent		
		1	2	3	4	5	
a) tables/counters		4	11	25	39	22	(61)
b) lighting		1	3	22	42	32	(62)
c) storage space for science materials/ equipment		10	19	27	27	16	(63)
d) amount of work space per student .		5	15	32	34	14	(64)
e) growing room/preparation room . .		20	18	23	20	15	(65)
f) storage space for student projects .		86	24	23	7	5	(66)
g) audio-visual equipment		3	9	33	37	18	(67)
h) storage space for acids		14	14	25	25	12	(68)
i) storage space for volatiles		19	12	24	23	12	(69)
j) gas outlets		4	7	19	39	29	(70)
k) water outlets		4	10	26	37	23	(71)
l) electrical outlets		4	9	20	36	31	(72)
m) sinks or drainage facilities . . .		7	10	27	31	24	(73)
n) fume hood/closet		15	10	24	21	13	(74)
o) safety equipment		6	15	38	30	10	(75)

Safety

6. How systematically is the safety equipment checked in your science area/room/laboratory?

a) no safety equipment	2	
b) casually, at best	31	
c) systematically; once a year	51	
d) systematically; more than once a year . .	16	(76)

7. (Multiple Response Item)

What safety equipment do you have in your science teaching area/room/laboratory?

a) none	3	*(77)
b) fire blankets	44	(78)
c) fire extinguisher	92	(79)
d) master gas shut-off	86	(80)
e) master water shut-off	24	(81)
f) approved first aid kit	61	(82)
g) safety goggles	54	(83)
h) asbestos gloves	19	(84)
i) sand buckets and scoops	9	(85)
j) eye wash stations	68	(86)
k) other (specify): _____		(87)

Equipment/Materials

8. Apart from minor changes, how often have you had to adapt your teaching plans this year because of difficulty in obtaining the necessary science equipment?

a) never	25
b) seldom; about once or twice	53
c) fairly often; about three or four times	13
d) quite often; about five or six times	5
e) far too often; more than six times	4
f) I seldom plan to use equipment	1

(88)

9. Overall, how do you rate the quality of the science equipment available to you?

a) excellent	20
b) good	60
c) tolerable	17
d) poor	2
e) very poor	1

(89)

10. How much input do you have in deciding what science materials/equipment are to be purchased?

a) none	1
b) not nearly enough input	11
c) about right	89

(90)

11. Who maintains and accounts for the science equipment in your school?

a) each science teacher looks after his/her own equipment	42
b) each science teacher looks after certain equipment	13
c) a specially designated science teacher	4
d) head of science department	20
e) paid assistants	16
f) nobody takes any responsibility	1
g) other (specify): _____	4

(91)

12. How difficult is it to obtain science equipment when you need it?

a) very difficult	8
b) somewhat difficult	25
c) not very difficult	44
d) not difficult at all	24

(92)

Reading Materials

13. How many DIFFERENT titles of science magazines or books (not textbooks) are usually available to your students in your science area/room/laboratory?

a) none	29
b) 1 - 5	51
c) 6 - 10	9
d) 11 - 15	3
e) more than 15	9

(93)

14. In your opinion how adequate are the science reading materials in your school library?

a) very inadequate	5
b) somewhat inadequate	19
c) satisfactory	46
d) very adequate	31
e) there is no school library	0

(94)

Attitude Toward Science Teaching

15. In your opinion, how worthwhile is the prescribed B.C. science program to the students you are presently teaching?

a) very worthwhile	43
b) of some worth.	55
c) of little worth	3
d) practically worthless.	0

(95)

16. If you had a choice, would you avoid teaching science altogether?

a) yes	2
b) undecided.	4
c) no	95

(96)

17. If you had a choice, at which grade level would you prefer to teach science?

a) none	0
b) primary/kindergarten	0
c) intermediate	1
d) junior secondary	1
e) senior secondary	91
f) post-secondary	7

(97)

18. As a rule, are you comfortable teaching science?

a) yes	96
b) no	0
c) in-between	3
d) no comment	1

(98)

19. How important do you think Senior Secondary science should be in a student's schooling?

- | | |
|---|----|
| a) more important than all other subjects | 1 |
| b) more important than most other subjects. | 27 |
| c) equal to other subjects. | 70 |
| d) less important than most other subjects. | 2 |
| e) less important than all other subjects | 0 |

(99)

20. In your opinion, how important do school and district administrators think Senior Secondary science should be in a student's schooling?

- | | |
|---|----|
| a) more important than all other subjects | 0 |
| b) more important than most other subjects. | 8 |
| c) equal to other subjects. | 79 |
| d) less important than most other subjects. | 13 |
| e) less important than all other subjects | 0 |

(100)

Teaching Load

21. What fraction of your teaching load this year is in science?

- | | |
|---|----|
| a) full load | 57 |
| b) more than half, but not a full load. | 23 |
| c) half load | 7 |
| d) less than half load. | 14 |

(101)

Preparation for Teaching

22. How many hours per week, on the average, are you given DURING SCHOOL HOURS for preparation and marking for your science classes?

a) no time during school hours	5
b) less than 1 hour	6
c) 1 - 2 hours	23
d) 3 - 4 hours	49
e) more than four hours	16

(102)

23. How many hours per week, on the average, do you need to prepare and mark for your science classes?

a) less than 1 hour	0
b) 1 - 2 hours	2
c) 3 - 4 hours	16
d) 5 - 6 hours	20
e) more than 6 hours	61

(103)

Marking Load

24. How do you handle the marking of students' lab write-ups?

a) I don't mark any write-ups	2
b) I mark all write-ups	68
c) I mark write-ups for a sample of the students for each experiment	3
d) I mark each student's write-up for a sample of experiments	24
e) I mark a sample of students' write-ups for a sample of experiments	4

(104)

25. What proportion of the lab/experiment write-ups that you mark receive detailed comments?

a) none	3
b) very few; well below half	26
c) few; about half	25
d) quite a few; well over half	30
e) all	16

(105)

26. Overall, how manageable is your marking load in science?

a) unmanageable	7
b) barely manageable	51
c) quite manageable	42

(106)

Teacher Education

Pre-Service

29. How adequately did your pre-service teacher education program in science prepare you for teaching science?

- | | |
|--|----|
| a) very inadequately | 21 |
| b) somewhat inadequately | 25 |
| c) adequately | 37 |
| d) very adequately | 14 |
| e) I had no teacher education program in science | 3 |

(22)

30. How much emphasis SHOULD be placed on each of the following in preparing student teachers to teach science? (Circle the appropriate number).

	Minor Emphasis					Major Emphasis
	1	2	3	4	5	
a) how to teach science	2	4	19	27	49	(23)
b) subject matter in specific areas of science	6	7	13	27	47	(24)
c) general science	6	8	40	31	16	(25)
d) history and philosophy of science . . .	18	28	33	16	5	(26)
e) psychology of learning	10	17	37	22	13	(27)
f) testing and evaluation in science . . .	2	7	30	40	22	(28)
g) psychology of adolescence	12	21	40	20	8	(29)
h) theories of intellectual development . .	25	26	34	12	5	(30)
i) survey of available curriculum materials .	5	10	32	35	18	(31)
j) how to develop curriculum materials . .	6	10	28	37	20	(32)
k) lesson planning	2	7	24	35	33	(33)
l) preparation of science materials . . .	1	3	25	44	26	(34)
m) practice in teaching science	0	0	6	25	68	(35)
n) discussion of problems of science teaching.	2	5	24	40	30	(36)
o) care and maintenance of equipment . . .	6	18	42	24	11	(37)
p) laboratory safety	2	11	31	28	28	(38)
q) special education	20	32	34	10	4	(39)
r) other (specify): _____						(40)

In-Service

31. How much in-service education do you feel you require this year to do a good job teaching science?

- | | | |
|----|--|----|
| a) | none | 21 |
| b) | 3 - 5 hours (one afternoon workshop) | 29 |
| c) | several sessions of 3 - 5 hours | 43 |
| d) | an intensive refresher course | 7 |

(41)

32. (Multiple Response Item)

Which forms of in-service have you had and which forms do you feel are of value?

	Have Had	Of Value	
a) informal meetings with other science teachers	91	87	*(42-43)
b) informal meetings with university science education instructors	48	53	(44-45)
c) informal meetings with scientists	33	42	(46-47)
d) workshops presented by other teachers	76	71	(48-49)
e) workshops presented by university science education instructors	52	50	(50-51)
f) workshops presented by scientists	29	40	(52-53)
g) workshops presented by Ministry of Education officials	16	21	(54-55)
h) formal (credit) university courses in science	39	47	(56-57)
i) formal (credit) university courses in science education	29	32	(58-59)
j) visits to other classrooms	50	55	(60-61)
k) other (specify):			(62-63)

33. How effective is the science in-service education program provided in your school/district?

- | | | |
|----|---|----|
| a) | no science in-service program is provided | 43 |
| b) | very ineffective | 17 |
| c) | somewhat ineffective | 24 |
| d) | fairly effective | 17 |
| e) | very effective | 11 |

(64)

34. Generally, how willing would you be to participate in an in-service education workshop in science during after school hours or on weekends?

- | | | |
|----|--|----|
| a) | definitely would not participate | 3 |
| b) | probably would not participate | 11 |
| c) | probably would participate | 48 |
| d) | definitely would participate | 31 |
| e) | cannot say | 7 |

(65)

35. Generally, how willing would you be to participate in an in-service education workshop in science during school hours if release time were given?

- | | | |
|----|--|----|
| a) | definitely would not participate | 1 |
| b) | probably would not participate | 2 |
| c) | probably would participate | 36 |
| d) | definitely would participate | 57 |
| e) | cannot say | 4 |

(66)

Science Budget

36. How much money has been allocated to the science program in your school this year?

- | | | |
|----|--|----|
| a) | not enough to teach the program properly | 14 |
| b) | enough to teach the program properly | 72 |
| c) | more than enough to teach the program properly | 5 |
| d) | I don't know | 9 |

(67)

Instructional Practices

37. About what percent of your evaluation of students in science is based on each of the following?

	0%	1-20	21-40	41-60	61-80	81-100%	
	↓	↓	↓	↓	↓	↓	
a) teacher made objective tests	2	11	26	34	21	7	(68)
b) standardized objective tests	64	26	8	2	1	0	(69)
c) subjective tests (essay, paragraphs, etc.)	20	39	24	10	6	1	(70)
d) laboratory/experiment write-ups	2	43	43	11	1	1	(71)
e) individual work contracts	84	14	0	1	1	0	(72)
f) reports on topics in science	41	55	3	0	0	0	(73)
g) projects	42	52	4	0	1	0	(74)
h) oral tests	81	19	0	0	0	0	(75)
i) student self-reports	88	11	0	0	0	0	(76)
j) anecdotal records of achievement	78	20	2	1	0	0	(77)
k) general attitude in class	44	54	1	1	0	0	(78)
l) work habits	39	51	2	1	0	0	(79)
m) other (specify): _____							(80)

38. How often do you engage your science classes in each of the following activities? (Circle the appropriate number.)

SCALE:	1	2	3	4	5	6	
	Never	Rarely (once or twice during course)	Occasion- ally	About half of the time	Frequently	Very frequently (almost every class period)	
							1 2 3 4 5 6
a)	carrying out experiments from a set of instructions . . .						0 2 28 22 44 7 (81)
b)	making up their own experiments						34 52 12 1 1 0 (82)
c)	discussing the possible errors in an experiment that has been completed						1 8 37 16 32 6 (83)
d)	listening to lectures						3 8 42 31 14 3 (84)
e)	making a graph from the data that the students get from an experiment						3 18 43 11 23 3 (85)
f)	applying information to new problem situations . . .						1 9 43 19 25 4 (86)
g)	making guesses about the results of an experiment . .						5 18 45 16 14 2 (87)
h)	interpreting or explaining for themselves the results of an experiment						1 6 31 24 32 7 (88)
i)	classifying objects or events						14 28 38 10 9 1 (89)
j)	describing/reporting observations in their own words .						2 4 27 22 37 8 (90)
k)	measuring in an experiment						1 5 27 19 39 10 (91)
l)	doing worksheets						10 19 42 12 14 3 (92)
m)	discussing results of an experiment with other students						2 8 37 18 30 4 (93)
n)	copying notes from the blackboard/overhead projector .						4 16 45 19 13 3 (94)
o)	working on problems at the end of a section in a book .						3 11 36 19 26 6 (95)
p)	memorizing scientific information						11 34 39 9 6 1 (96)
q)	doing investigations at home						35 48 15 1 1 1 (97)
r)	reading from textbooks						4 17 40 18 19 3 (98)
s)	doing research in the library						12 42 36 6 4 0 (99)

39. Which time-table patterns does your school have?

a)	Quarter	2	
b)	Semester	58	
c)	Regular full year	37	
d)	Other (specify): _____	3	(100)

40. Which time-table pattern would you prefer?

- | | |
|-------------------------------------|----|
| a) quarter | 3 |
| b) semester | 33 |
| c) regular full year | 61 |
| d) other (specify): _____ | 3 |

(101)

41. Do you have enough time to cover the science courses?

- | | |
|------------------------------------|----|
| a) more than enough time | 1 |
| b) enough time | 27 |
| c) almost enough time | 33 |
| d) not enough time | 39 |

(102)

Self Rating

42. How would you rate your teaching performance in science?

- | | |
|----------------------------|----|
| a) poor | 0 |
| b) below average | 1 |
| c) average | 13 |
| d) good | 63 |
| e) excellent | 19 |
| f) no comment | 4 |

(103)

Student Attitudes

43. How has student interest and motivation in learning science at school changed over the last four or five years?

- | | |
|---|----|
| a) no opinion | 9 |
| b) cannot notice any change | 41 |
| c) motivation seems to have increased | 26 |
| d) motivation seems to have decreased | 25 |

(104)

Effectivness of Teaching

44. How would each of the following changes be likely to effect the quality of science learning in your classroom? (Circle the appropriate number.)

3 (10)

KEY: The quality of learning would likely:

1	2	3	4	5
Improve Greatly	Improve Somewhat	Remain the Same	Deteriorate Somewhat	Deteriorate Seriously

	1	2	3	4	5	
a) more direct input by you into the purchase of equipment .	6	29	66	0	0	(11)
b) better quality of equipment	8	51	41	0	0	(12)
c) less responsibility for maintenance of equipment . .	4	22	57	13	4	(13)
d) smaller class size	23	40	35	2	1	(14)
e) provision of wider selection of printed materials (texts)	24	48	26	2	0	(15)
f) more leadership and coordination at school level . .	4	28	65	3	0	(15)
g) more leadership and coordination at district level . .	8	41	45	5	2	(17)
h) decreased emphasis on core	2	12	58	22	6	(18)
i) increased provision of in-service	8	65	25	1	1	(19)
j) more science books in the library	8	48	44	0	0	(20)
k) more time for preparation and marking	26	51	22	0	0	(21)
l) fewer classes to teach	23	46	30	1	0	(22)
m) more convenient storage space for equipment	9	38	52	1	0	(23)
n) more university courses in science (taken by yourself)	7	49	43	1	0	(24)
o) higher priority placed on science by administration .	3	34	62	1	1	(25)
p) less in-service education	0	2	52	41	5	(26)
q) more time allocated to science	9	58	31	2	0	(27)
r) less time allocated to science	0	1	20	59	20	(28)
s) fewer subjects/levels to teach	9	40	49	2	0	(29)
t) increased emphasis on core	4	23	56	15	2	(30)

45. What are your views on the introduction of a general science course at the Grade 11 level for some students?

- a) this should be done as soon as possible . . . 19
- b) it would be worth a try . . . 42
- c) there is no great need for it. . . 21
- d) it would be a waste of time and money . . 14
- e) other (specify): _____ . . . 3

(31)

46. If a general science course were to be introduced at the Grade 11 level, would you teach it?

- a) yes . . . 64
- b) no . . . 36

(32)

PHYSICS: IF YOU DO NOT TEACH PHYSICS, IGNORE QUESTIONS # 47.

47. A. How often do your students use the following books in Physics?
(Circle the appropriate number.)

	Never	Occasionally	Regularly	
a) Labtext (Laboratory Course in Physics . . .	3	18	79	(33)
b) P.S.S.C.	6	37	57	(34)
c) Physics: A Human Endeavour	90	8	2	(35)
d) Project Physics	77	21	3	(36)
e) Concepts in Physics	88	10	3	(37)
f) Other (Specify): _____				(38)

47. B. There is a suggestion that a more general Physics course be introduced to meet the needs of more students than the present course does. What course of action do you recommend?

- a) retain the present course only . . . 13
- b) retain the present course and introduce a more general course for some students . 63
- c) replace the present course with a more general course . . . 8
- d) retain the Grade 12 course, but replace the Grade 11 course with a more general course . . . 16

(39)

47. C. If a more general Physics course were to be introduced, would you like to teach it?

- a) yes . . . 83
- b) no . . . 17

(40)

CHEMISTRY: IF YOU DO NOT TEACH CHEMISTRY, IGNORE QUESTIONS # 48.

48. A. How often do you use the following? (Circle the appropriate number.)

	Never	Occasionally	Regularly	
a) Keys to Chemistry	47	45	8	(41)
b) The Nature of Matter	46	37	17	(42)
c) Inquiries in Chemistry	29	35	35	(43)
d) The 'old' course (Chem Study)	4	28	68	(44)
e) Other (Specify): _____				(45)

48. B. (Multiple Response Item)

Which texts would you like to use next year?

a) Keys to Chemistry	30	*(46)
b) The Nature of Matter	30	(47)
c) Inquiries in Chemistry	66	(48)
d) The 'old' course (Chem Study)	44	(49)
e) Other (Specify): _____		(50)

BIOLOGY: IF YOU DO NOT TEACH BIOLOGY, IGNORE QUESTIONS # 49.49. A. How frequently do you use the following texts in Biology 11?
(Circle the appropriate number.)

	Never	Occasion- ally	Regu- larly	
a) B.S.C.S. textbook (green version)	6	44	50	(51)
b) B.S.C.S. Biological Science: An Inquiry into Life Lab Text (yellow version)	13	60	28	(52)
c) B.S.C.S. Biological Science (blue version)	87	13	1	(53)
d) Laboratory and Field Investigations (Miller and Vance)	43	56	2	(54)
e) Laboratory Manual Biological Science (Gregory)	19	52	30	(55)
f) Laboratory Outlines in Biology (Abramoff and Thomson)	15	57	28	(56)
g) B.C. Curriculum Guide for Biology 11	21	52	27	(57)
h) Animals Without Backbones (Buchsbaum)	2	27	71	(58)
i) Resource Book of Test Items	47	38	15	(59)
j) Student Lab Outline (Ministry of Education)	58	32	10	(60)
k) A Guide to the Study of Freshwater Biology (Weedham and Weedham)	13	72	15	(61)
l) Trees, Shrubs and Flowers to Know in B.C. (Lyons)	10	70	20	(62)
m) B.S.C.S. Lab Blocks: (1) Field Ecology	39	59	2	(63)
(2) Life in the Soil	46	53	1	(64)

- | KEY: | 1 | 2 | 3 | 4 | |
|--|------------|----------|---------------|------------|-------------------------|
| | Unsuitable | Suitable | Very Suitable | Don't Know | |
| | | | | | <u>1 2 3 4</u> |
| a) B.S.C.S. textbook (green version) | 32 | 45 | 22 | 1 | (65) |
| b) B.S.C.S. Biological Science: An Inquiry Into Life lab text (yellow version) | 7 | 55 | 33 | 5 | (66) |
| c) B.S.C.S. Biological Science (blue version) . | 18 | 22 | 7 | 53 | (67) |
| d) Laboratory and Field Investigations (Miller and Vance) | 32 | 49 | 6 | 13 | (68) |
| e) Laboratory Manual Biological Science (Gregory) | 14 | 47 | 33 | 6 | (69) |
| f) Laboratory Outlines in Biology (Abramoff and Thomson) | 19 | 49 | 34 | 5 | (70) |
| g) B.C. Curriculum Guide for Biology 11 | 22 | 59 | 16 | 3 | (71) |
| h) Animals Without Backbones (Buchsaum) | 1 | 15 | 82 | 3 | (72) |
| i) Resource Book of Test Items | 6 | 37 | 18 | 39 | (73) |
| j) Student Lab Outline (Ministry of Education) . | 44 | 32 | 9 | 15 | (74) |
| k) A guide to the Study of Freshwater Biology (Weedham and Weedham) | 7 | 52 | 34 | 6 | (75) |
| l) Trees, Shrubs and Flowers to Know in B.C. (Lyons) . | 6 | 45 | 45 | 3 | (76) |
| m) B.S.C.S. Lab Blocks: (1) Field Ecology . . . | 19 | 57 | 14 | 10 | (77) |
| (2) Life in the Soil | 19 | 54 | 12 | 15 | (78) |

- | KEY: | | 1 | 2 | 3 | 4 | 5 | |
|------|-----------------------------|---------------------|----------|----------|----------|---------------------|--------------------------|
| | | 10 hours
or less | 20 hours | 30 hours | 40 hours | 50 hours
or more | |
| | | | | | | | <u>1 2 3 4 5</u> |
| a) | Ecology | | | | | | .14 35 38 13 0 (79) |
| b) | Diversity | | | | | | .1 7 23 56 13 (80) |
| c) | Evolution | | | | | | .59 28 10 2 1 (81) |
| d) | Optional material | | | | | | .53 29 12 6 0 (82) |

IF YOU DO NOT TEACH BIOLOGY 12, IGNORE THE REST OF QUESTIONS # 49.

49. D. How frequently do you use the following materials for Biology 12?
(Circle the appropriate number.)

KEY:	1	2	3	
	Do Not Use	Occasionally Use	Regularly Use	
				1 2 3
a) Investigations of the Cells and Organisms (Laboratory Study Guide in Biology - labtext)				11 51 38 (83)
b) Foundations of Biology textbook				1 10 88 (84)
c) B.C. Curriculum Guide for Biology 12				17 42 41 (85)
d) Other sources of materials				3 32 65 (86)

49. E. Rate the following course materials in terms of their suitability for Biology 12. (Circle the appropriate number.)

KEY:	1	2	3	4	
	Unsuitable	Suitable	Very Suitable	Don't Know	
					1 2 3 4
a) Investigations of Cells and Organisms (Laboratory Study Guide in Biology - labtext)					38 52 10 1 (87)
b) Foundations in Biology textbook (McElroy)					22 45 33 0 (88)
c) Workbook of Investigations of Cells and Organisms					56 32 5 6 (89)
d) Dissection of the Fetal Pig					2 30 66 1 (90)
e) Dissection Guide for the Fetal Pig					1 35 65 1 (91)
f) Other sources of materials					0 28 65 7 (92)

49. F. Roughly, how much time do you spend in Biology 12 on:
(Circle the appropriate number.)

KEY:	1	2	3	4	5	
	10 hours or less	20 hours	30 hours	40 hours	50 hours or more	
						1 2 3 4 5
a) Physiology						0 2 8 34 56 (93)
b) Cellular Biology						4 19 29 34 15 (94)
c) Evolution						431 71 24 3 7 1 (95)
d) Optional materials						59 31 21 2 1 (96)

49. G. Do you feel that there ought to be an alternative course concentrating on human biology at the Grade 11 level?

a) yes 64
b) no 36

(97)

49. H. Would you teach such a course if it were an option?

a) yes 92
b) no 8

(98)

49. I. (1) Do you feel that Biology 12 is too content oriented?

a) yes 36
b) no 64

(99)

(2) Should there be more human biology in Biology 11?

a) yes 53
b) no 47

(100)

(3) What changes do you feel are required in the Biology 11 and 12 programs?

(101)

EARTH SCIENCE/GEOLOGY: IF YOU DO NOT TEACH EARTH SCIENCE OR GEOLOGY,
IGNORE QUESTION # 50.

50. If you teach Earth Science 11 or Geology 12, please comment freely on these courses.

(102)

APPENDIX B

TEACHERS' WRITTEN COMMENTS ON QUESTIONNAIRES

On the last page of each teacher survey questionnaire was an invitation for teachers to write in comments. The number of teachers who responded to this invitation was 1,224, made up of 650 of the elementary teachers, 316 of the junior secondary teachers, and 258 of the senior secondary teachers.

The comments were categorized by Ms. Marsha Boseman. Typical comments are given in the following pages, together with the frequency of similar comments.

The comments should not be taken as representative of the sample. They give insights into various aspects not covered by the survey questions as well as clues to the reasons for various response patterns to the survey.

PART I - ELEMENTARYElementary CurriculumFrequency S.T.E.M.

- 53 - Guidebooks and/or textbooks are not yet available.
- 22 - Prefer the STEM program over the others offered.
- 15 - The STEM programs arrived too late to implement and test.
- 11 - Equipment and materials required by STEM are not readily available.
- 7 - The reading level for the STEM program is too high.
- 3 - STEM textbooks provide the answers to questions too easily.
- 3 - STEM has too many activities to cover in one year.
- 3 - STEM does not provide a kindergarten program.
- 3 - STEM guidebook provides a good resource for teacher information.
- 3 - STEM textbook and curriculum are too simple and need a more in-depth study of the concepts.
- 2 - Dislike the STEM program.
- 1 - Some STEM experiments do not work consistently.

Materials Based

- 13 - Prefer the Materials Based Program over others offered.
- 5 - Dislike the Materials Based Program.
- 2 - Materials Based Program required too much time to set up and cover the material.
- 2 - Would like the Materials Based Program kept available even if another program is prescribed.
- 1 - Guidebooks and/or textbooks are not available.
- 1 - Materials Based Program arrived too late to implement and test.

Exploring Science

- 35 - Prefer Exploring Science Program over others offered.
- 47 - Guidebooks and/or textbooks are not available or have not yet arrived.
- 12 - Exploring Science Program arrived too late to implement and test.
- 8 - Favour the Exploring Science textbook and guidebook.
- 6 - Materials required by Exploring Science Program are not readily available.
- 2 - Dislike the Exploring Science Program.
- 10 - The Exploring Science text and curriculum are too simple for this level and should provide a more in-depth study of the concepts.

Frequency Elementary Science Study and Kits

- 3 - Prefer the Elementary Science Study Program.
- 3 - Not enough time to cover the Elementary Science Study Program.
- 2 - Dislike the Elementary Science Study Program.
- 2 - Materials required by the Elementary Science Study Program are not readily available.

General - New Program

- 43 - Prefer a combination of the programs offered (as developed into teacher-prepared units).
- 5 - Enjoy having the choice of various programs.
- 4 - More teacher input needed in programs.
- 3 - Not enough "hands on" in Laidlaw (Exploring Science).
- 3 - Laidlaw (Exploring Science) guidebooks have not yet arrived.
- 1 - Prefer the old 1960's guidebook ("Desired Outcomes" are clearly defined and teaching suggestions are useful).
- 7 - Locally directed units to incorporate the environment (social and ecological) into the science program.
- 5 - Science should be related to the modern world (health, conservation, recent developments in science).
- 5 - More field trips to increase students' knowledge of the the local environment.
- 11 - A curriculum that can be adapted to the wide range of students' abilities and multigrade classes.
- 7 - A program that included ideas for kindergarten science.
- 5 - Specialists should conduct the science program in each school.
- 4 - More emphasis on theory, less on discovery learning.
- 2 - Should be a forestry unit included in the curriculum.
- 2 - Should be a method of teaching children how to work independently and to record data.
- 2 - Activities that can be student-initiated would be of great assistance.
- 2 - Would like to see a less restricted scope in the science program.
- 1 - Like to see a combination of the new and old programs.
- 1 - There should be less frequent changes in the prescribed science course.
- 1 - Need a central science facility for the district - providing all equipment, a library, and an adequate laboratory facility.

Continuity, Structure, Core

Frequency Respondents would like to see:

- 56 - Provincially-imposed exhaustive outline of the topics to be covered by each grade (to avoid overlapping and inconsistent instruction from year to year and school to school).
- 16 - A provincially-provided delineation of the objectives to be attained in each topic.
- 11 - A provincially-provided framework or guideline for each grade, allowing for teacher input and flexibility in the method of instruction.
- 4 - More coordination of science at the district level.
- 3 - More coordination of science at the school level.
- 2 - Provincially-supplied lesson plans prepared by active teachers.
- 2 - The use of a standard textbook.

Integrating Science Into Other Subjects

- 28 - Science is frequently incorporated into the language Arts readings and discussions to give adequate time to both areas at the primary level.
- 22 - At the kindergarten level, science is taught spontaneously and is integrated into daily activities (allowing for student interest to spark enthusiasm).
- 9 - Incidental instruction, impromptu lessons, show and tell, "teachable moments" - these constitute the science program.
- 5 - There is a definite bias towards teaching the Language Arts and Arithmetic before Science.
- 4 - "Formal" science has no place at the primary level.
- 3 - Integration of subjects requires more time for preparation and more material (films, story books, etc.) to supplement the lessons.

Textbooks and Guidebooks

- 31 - Need one textbook per child to facilitate reading, assignments, and homestudy.
- 18 - Would like to see a set of science-based readers to integrate science and the Language Arts.
- 5 - Textbook vocabulary is above the assigned grades' reading level.
- 4 - Need lists of available resource material on specific subjects for speedy location of information.
- 4 - Must adapt the experiments to a classroom situation.
- 4 - Textbooks need more questions and assignments as well as suggestions for discussion.
- 3 - Would like to see the history of science included in the texts.
- 3 - Need texts with enticing pictures and simple captions.
- 3 - Textbooks and stories for kindergarten are difficult to find (need a list of available readings).

Frequency Textbooks and Guidebooks (Continued)

- 2 - Would like the texts to include standard format for experiments (ie., Problem, Materials, Procedure, Observations, Results, Conclusions)

Recommended Texts from Teachers Comments

1. Science Experiences for Young Children
Althouse & Main, Teacher's College Press, Columbia University
2. Laidlaw program
3. Ontario Institute for Studies in Education (O.I.S.E.) Booklet
4. Teacher Developed Manual (from North Vancouver)
5. Science - A Process Approach (for kindergarten)
6. Modular Activities Programme in Science
7. The lists and teacher's manuals compiled by: Harold E. and Beulah Tannenbaum and Nathan and Myra Stillman
8. Explorations in Science
9. Science I - People, Concepts, Processes
McGraw Hill

Apparatus and Materials

- 60 - Materials for the new programs are not available.
- 30 - Need storage space and display tables for continuing projects.
- 30 - Lab facilities are needed with sufficient electrical outlets, flat-topped desks, water and gas outlets, sinks.
- 21 - More supportive material needed in the form of workbooks, progress charts, audio-visual presentations, etc.
- 15 - Too much time is required to retrieve and set up the equipment.
- 11 - Equipment is often of inferior quality and is easily broken.
- 9 - The Resource Centres do not always have the equipment available or it is not in good condition.
- 10 - Need district leadership for organization of materials.
- 7 - Teachers are frequently buying the necessary equipment from their own personal funds.
- 7 - Currently have a purchasing committee and/or coordinator.
- 6 - Program materials did not arrive in time to implement them properly this year.
- 6 - Living organisms are difficult to keep in the classroom because of arctic winters, allergies, "manhandling" of the animals by the children.

Frequency Apparatus and Materials (Continued)

- 4 - Children are forced to bring materials from home due to the lack of equipment at the school.
- 4 - Kindergarten classes are the last to receive any equipment.
- 4 - Need adequate safety equipment.
- 3 - Must provide funds for replenishing consumable materials.
- 4 - The schools need: a) windows
- 3 b) microscopes
- 3 c) magnets
- 2 d) tuning forks
- 2 - Materials must be made available locally and at a reasonable cost.

Time

- 15 - Science periods must often be cut short because of the importance of the Language Arts and Mathematics.
- 15 - Lack of preparation time to organize programs and the daily agenda.
- 7 - Need a teacher's aide to help in setting up and clearing equipment, marking, etc.
- 6 - Better organization of a complete science program would improve the curriculum by reducing the amount of time required for preparation of the lessons.
- 2 - Time does not allow for field trips.
- 1 - Time should be given each teacher for in-service.

In-Service Education

- 25 - In-service needed to gain in-depth understanding of the newly introduced programs.
- 16 - Must give student teachers better preparation in the area of science programs, improvising with equipment, etc.
- 13 - Teacher-to-teacher discussions needed or a science specialist touring the schools and 'coaching' teachers on a regular basis.
- Would like to see workshops provide specific information on the following:
 - 8 Applicable demonstration experiments.
 - 8 Sample unit plans.
 - 5 Suggestions for enrichment
- 7 - In-service should be given during school hours.
- 7 - Provide summer school courses in science.
- 4 - Would not attend workshops if given.
- 3 - Have never had an opportunity to attend in-service workshops in this area.

Frequency	Questionnaires
53	- The questionnaire arrived too soon as the programs have not yet been implemented or fully tested.
24	- The questionnaire was too long and too time consuming.
21	- Not all questions were applicable to the respondent's situation.
16	- Respondent does not teach science regularly.
13	- Respondent questioned the validity and value of the questionnaire.
12	- Kindergarten has no formal program thus making the questionnaire inapplicable or difficult to answer.
11	- Respondent does not currently teach science (or not at the level he/she was requested to complete the questionnaire for).
6	- Semantic problems (errors, vagueness, etc.)
7	- The questionnaire should have been issued separately to intermediate and primary levels.
56	- Respondent would like to obtain some feedback on the results of the questionnaire.
4	- The questionnaire promoted an awareness of current problems.
3	- Questions II and V identify the respondent and appear to be unnecessary.
3	- Question 51 - the rating scale differs.
3	- Question 45 - should allow for a combination of the answer choices.
3	- Questions 52 and 53 - microscopes should have been included.
2	- Questions 52 and 53 - unnecessary.
2	- Question 39 - prefer a combination of those listed.
2	- Should have a locally conducted survey.
2	- The objectives of the questionnaire should have been discussed with the teachers.
2	- Many questions were redundant.

PART II - JUNIOR SECONDARYFrequency Curriculum - General

- 18 - Make material more relevant by applying concepts to everyday life (environmental problems, energy population).
- 6 - Should have one or two required courses and three or four optional science courses (with teachers specialized in one or two areas).
- 3 - More emphasis needed on local environment.
- 3 - More emphasis needed on health science education.
- 2 - More dissection needed to retain student interest.
- 2 - Grade 8 science should be a "general science" program.
- 1 - Should give both points of view regarding theory of evolution.
- 1 - Should include oceanography in junior science.

Continuity, Structure, Core

- 32 - Provincially - outlined core concepts to be taught in each year allowing for teacher input and some flexibility in the form of optional units.
- 18 - Too much to learn in each year in junior science (especially under the semester system).
- 13 - Reduce class sizes (20 - 25).
- 15 - Rooms need updating.
- 11 - Need less emphasis on discovery approach.
- 8 - Would like to see regular provincial learning assessments or standardized tests.
- 7 - More coordination needed at the district level.
- 5 - More emphasis on the practical application of concepts to problem solving.
- 5 - Semester and quarter systems interfere with the continuity of the programs.
- 4 - Need sequential learning between elementary and junior secondary schools.
- 4 - Learning outcomes should be clearly defined and correlated to objectives on a provincial basis.
- 4 - History of science should be included in the curriculum.
- 3 - More coordination needed between the math and science departments.
- 2 - Students need more direction at this level.

Curriculum - Terminal Science Students and Fundamental Skills

- 46 - Teachers need a detailed course outline for slower students (non-academics).
- 13 - Special courses are needed for those students taking junior science as terminal science courses.
- 12 - Need courses structured to cater to all abilities (below average, average, and above average).
- 8 - Currently use ISCS, ISIS, or IIS.
- 3 - Would like independent study course outlines.

Frequency	Textbooks
49	- Reading level is too high for many students of average to below-average ability.
25	- Reading material frequently does not give enough information to do the labs and answer the questions.
19	- Need more theory with problems and descriptions related directly to the labs.
17	- Favour the new Grade 8 test.
18	- Dislike the reading about science text.
13	- Science 10 text is too difficult (too many equations, difficult concepts, and because students lack an adequate background in science).
13	- Texts need to be adapted so that students can study from them (for absentees, homework, exams).
12	- Lab books lack adequate information and are confusing to students.
11	- Need more questions at the end of each chapter.
8	- Teachers guide is nebulous and inadequate.
8	- More emphasis needed on developing observational skills and work habits.
7	- Dislike the Science 9 texts.
6	- Dislike chemistry section of science 9.
5	- Need a variety of project books, workbooks, or books on each topic/unit.
4	- Grade 10 text is very dull.
4	- Procedure outlines should be more complete.
3	- Need one text per pupil.
3	- Grade 8 unit on optics should be given in a higher grade.
Favour reading about science (grade 10)	
3	- Chemistry
2	- Physics
2	- Biology
2	- Earth Science

Reading Material Suggested in Teachers' Comments

1. Science in Action by Wallis and Ozard
2. Challenges in Science - Cebco Standard Publishing (motivating presentation, good for all abilities)
3. Physical Sciences - Ginn (especially chemistry section)
4. Extending Science Concepts in the Lab
5. Life in the Environment - Navarra et al (Harper and Row 1973)
(Taxonomy of plants and animals)
6. Idea-Centred Laboratory Science - Wm C. van de Ventee (Michigan)
(for 9 and 10 level)

Suggested Reading Material (Continued)

7. Pathway in Science
8. Physical Science for Progress
9. Physical Science - A Search for Understanding
10. Interaction of Man and the Biosphere - used in Grade 9
11. Interaction of Matter and Energy - used in Grade 10
12. "Why not Nuclear" - V.P. of Atomic Energy of Canada
13. Earthquake Prediction - Sc. Teacher 1978
14. "Last Command" - A.C. Clarke
15. "Wildflower" - John Wyndham
16. V.A.S.T. Science - (Vocational Adult Secondary Training)

Frequency Apparatus and Materials

- | | |
|----|--|
| 15 | - Need more inexpensive reference material or a more complete science section in the library. |
| 10 | - Need more audio-visual equipment, films, articles, unit tests, worksheets, reviews, summaries. |
| 8 | - Lack of funds for purchasing new equipment and replacing "consumable" materials. |
| 5 | - Lack of electrical and gas outlets. |
| 5 | - Equipment is of poor quality. |
| 5 | - Safety equipment needed (should be inspected annually). |
| 5 | - Need direct input into purchase of equipment. |
| 4 | - Orders are often inconsistent resulting in attachments to equipment being different brand and not fitting. |
| 4 | - Lack of storage space. |
| 3 | - Need a budget for student projects. |

Time

- | | |
|----|--|
| 12 | - Need more time for marking so that more and better assignments can be given. |
| 11 | - Need more preparation time. |
| 10 | - Much time is spent rewriting the labs. |
| 5 | - Need lab assistants to set up equipment, prepare class material (typing and revising) and marking. |
| 4 | - Need at least one free block in each semester. |

Frequency In-Service Education

- 13 - More preparation of student teachers for work load, setting up a curriculum (specific methods), and dealing with equipment shortages and breakage.
- 9 - Need teacher-to-teacher conferences and suggestions.
- 4 - Provide detailed lesson plans.
- 4 - Locally organized weekend workshops.
- 3 - In-service must be practical.
- 3 - One or two week summer courses.
- 3 - Tips for field trips, classroom management, and motivation.
- 1 - Winter evening courses.
- 1 - Teachers should be given a budget for in-service education.

Questionnaire

- 13 - Respondent does not teach science regularly (or not the level he/she was required to answer for).
- 7 - Clarifications of responses.
- 6 - Survey was too long and time consuming.
- 5 - Survey provided an opportunity to voice an opinion.
- 5 - Question 23 - this was an insult to have "more than six" (most felt "more than fifteen" more accurate).
- 5 - Many questions were too vague or general.
- 4 - Limited experience made answering difficult.
- 4 - #54 scale is inconsistent.
- 3 - Would like some feedback.
- 2 - Question I to V are inappropriate.
- 2 - Question utility of surveys.
- 1 - #31 poorly worded.
- 1 - More questions needed regarding local Resource Centres.

PART III - SENIOR SECONDARY

Note: The senior secondary teachers who commented were teachers of the following subjects:

Biology	(127 teachers)
Chemistry	(38 teachers)
Physics	(46 teachers)
Geology or Earth Science	(20 teachers)

In most sections of Part III, two percentages are given for most comments. The larger is a percentage of the number of teachers of the particular subject in question, and the smaller is a percentage of the total number of senior secondary teachers. For example, the first comment below was made by 13.0 percent of the physics teachers, or 2.3 percent of the senior secondary teachers who commented.

Frequency Physics Curriculum - General

- 6 - Should have a more general physics course for students taking physics 11 as a terminal course.
- 4 - Some history should be included in physics 11.
- 5 - Students need a better math background.
- 2 - Students need a better background in junior science.
- 2 - Step from physics 11 to physics 12 is too great a leap for most students.
- 2 - Astronomy should be included in physics 11.
- 2 - Must relate courses to practical events.
- 2 - Calculators should be permitted on scholarships.
- 2 - Physics 12 is good university preparation course but is too difficult for most students.

Physics Curriculum - Continuity, Structure, Core

- 3 - A physics core outline should be introduced but should be vastly reduced in size to allow for projects, research, side excursions.
- 3 - Re-organize physics curriculum from grades 8-12 to produce sequential learning.
- 3 - Need a survey physics 11 course for non-academic students.
- 2 - Need a more understandable approach to learning the concepts.

Frequency Physics - Texts

- 9 - Reading level of texts is too high.
- 8 - Need a basic text combined with a problem book.
- 7 - Dislike the PSSC text (it is too wordy and difficult to read).
- 5 - Need more exercises in texts (must provide an answer key).
- 3 - Dislike Livesey's lab text.
- 2 - Texts need metrification.
- 2 - Questions in PSSC are too difficult.
- 2 - Need a smoother transition from topic to topic.

Recommended Texts in Teachers' Comments

1. Johan College Physics, 51 edition
2. Camosun College Text - Norm Puston
3. Concepts in High School Physics
4. Physics - A Human Endeavour

Physics - Apparatus and Materials

- 2 - Need sturdier equipment.
- 2 - Films are outdated
- 1 - Need resource areas and storage facilities.
- 1 - Lack of funds for new equipment.
- 1 - Classes need a lab area and an instructional area.
- 1 - Would like to see a computer in use.

Physics - Time

- 2 - Teacher-demonstrated labs would save much time and allow for better equipment to be used.

Chemistry Curriculum - General

- 6 - Chemistry 11 course does not offer much to students not continuing in chemistry (should provide alternative material for those students).
- 4 - Need more resource material.
- 4 - Greater emphasis needed on organic and consumer chemistry.
- 1 - Topics on scholarship exams bear little resemblance to the course outlines.
- 1 - Less emphasis on math in chemistry will help the bottom 40 percent of the class.

Frequency Chemistry Curriculum - Structure, Continuity, Core

- 6 - Must maintain a high level of learning in senior chemistry (basic concepts, theory, at an adult level).
- 4 - Standard provincial exams are needed.
- 3 - Provincial direction needed (an outline of the core program and what topics should be covered as well as the depth to which they must be covered). The topics should follow a logical sequence from year to year.
- 1 - More province-wide standardization needed.
- 1 - More theory should be taught before labs are performed.
- 1 - Respondents do not want a standard science course (prefer flexibility in teaching).

Chemistry - Textbooks and Lab Books

- 4 - More problems needed (and practice exercises).
- 3 - More teacher input needed in selection of textbooks.
- 3 - Update the lab books to make them more readable.
- 3 - Like the "Inquiries in Chemistry" grade 11 text, but more background information is needed.
- 3 - Dislike the "Nature of Science" text.
- 3 - Readability levels must be more suited to the grade 12 level (currently too low).
- 2 - Like the format of "Chemstudy".
- 2 - Dislike chemistry 11 textbooks.

Chemistry - Apparatus and Materials

- 3 - More input needed into purchase of equipment.
- 3 - Lack of funds for new equipment and for replacing chemicals.
- 3 - Need safe and workable storage facilities.
- 2 - Must have sufficient notice to order appropriate equipment for new programs.
- 1 - Need to have safety goggles available.

Chemistry - Time

- 3 - Need a lab assistant for marking, setting up equipment, preparation, etc.
- 3 - Need time for lesson preparation.
- 2 - Semester system is rushed; cannot finish the prescribed course.
- 2 - Need time for marking.
- 2 - Need time for equipment set up.

Frequency Geology Curriculum - General Comments

- 7 - Course is often viewed as a "dumping ground" for students not taking chemistry, physics, or biology.
- 5 - Course tends to overlap that learned in others such as geography.
- 4 - Outline topics to be covered at each level.
- 4 - More emphasis needed on interdisciplinary facets of science (ecology, man and science).
- 4 - Geology should be considered as a credit course.
- 4 - Materials for labs are not available.
- 2 - Not enough time to cover all topics.
- 2 - Collection of lab activities would be useful.
- 2 - Core material should be more comprehensive.
- 2 - Would like to see astronomy included in the geology curriculum.
- 2 - Some lab activities are far too simple.
- 2 - Lack of funds to set up the course.
- 2 - Students need more background in earth science before entering senior level geology.
- 2 - Course should develop to include energy conservation, nutrition, nuclear energy, pollution, pesticides, consumer science.

Geology - Textbooks

- 3 - Need a class set of textbooks
- 3 - Choice of texts is limited.
- 2 - Need a comprehensive lab manual.
- 2 - Periodicals would be most helpful.

Recommended Geology Reading Material

1. Earth Science by Ordway (periodical)
2. Geology & the New Global Tectonics
By J.R. James, MacMillan of Canada, 1976

Biology Curriculum - General Comments

- 24 - More emphasis needed on human biology.
- 7 - Other topics would be of greater value than biochemistry of respiration and photosynthesis.
- 5 - Less emphasis on ecology and evolution.
- 5 - Scholarship exams need regularity in format.
- 4 - More emphasis on diversity and evolution.
- 4 - The curriculum guide must indicate the depth to which each topic must be covered.
- 4 - Less emphasis on diversity in biology 11.

Frequency Biology Curriculum - General Comments (Continued)

- 3 - Cell biology should be taught in biology 11.
- 3 - Alternate philosophies of origin should be presented (evolution vs. bible).
- 3 - Genetics needs more attention at the senior level.
- 3 - More provision must be made for the study of local ecology.
- 3 - Better background needed in biology before biology 11.
- 2 - Course should consider the impact of applied technology on man and his environment.
- 2 - Less emphasis should be placed on phylogeny in biology 11.

Biology Curriculum - Structure, Continuity, Core

- 6 - Course should cover DNA, genetics, mutations, etc., prior to studying evolution.
- 5 - Need continuity between biology 11 and 12.
- 2 - Must have a good background in biology and a framework upon which to build further skills.
- 2 - There should be standardized district-wide tests to ensure that teachers follow the curriculum outline.
- 7 - Need two courses in biology (one for those entering university and one for those not continuing in science).

Biology - Textbooks

- 12 - Would like to return to the yellow version of the B.S.C.S. text.
- 12 - Dislike the B.S.C.S. green version.
- 11 - Dislike the biology 12 textbook.
- 8 - Dislike the biology 12 lab book.
- 8 - Satisfied with biology 12 course content.
- 8 - Many of the exercises in the lab text "Investigations of Cells and Organisms" are not challenging enough.
- 7 - Lab text should correspond to the text book.
- 7 - Less emphasis on biochemistry (it is too advanced for those without a chemistry background).
- 6 - Biology 12 textbook is difficult to understand.
- 5 - Must have a B.S.C.S. text that is sequential (current text is too disjointed).
- 5 - Texts need to be Canadianized.
- 4 - Biology 12 text is repetitious and gives an uneven coverage of each topic.
- 3 - "Foundations of Biology" is too advanced for biology 12.
- 3 - "Animals Without Backbones" should be issued to every student.
- 3 - Biology 11 textbook is too difficult.
- 3 - Like the blue version of B.S.C.S. as a major reference for biology 11 and 12.
- 1 - Biology 12 text needs follow-up on concepts and vocabulary introduced in each chapter.

Biology - Reading Materials Suggested by Teachers

1. Elements of Biology (Canadian version)
by Dr. Weisz
2. Scientific Creationism by Henry M. Morris
Life Publishers, San Diego California
3. Modern Biology by Otto and Towles, 1977
4. Biology - Living Systems Orom, Hummer, & Smout, 1976
5. Physiology by McNaught & Callander
6. Investigations in Biology (prepared by Calgary & District
Biology Teachers' Association)
Addison & Wesley, 1977 publishers
7. Probing Levels of Life by Hummer Kaskela et al
Published by Charles Merrell, 1973
8. Needham text
9. Inquiring into Life, by S. Mader, 1976

Frequency Biology - Apparatus and Materials

- | | |
|---|--|
| 3 | - Better resources for field study needed. |
| 3 | - Need more reference and resource material. |
| 2 | - Apparatus is of poor quality and will not stand up to continuous handling by students. |
| 2 | - Class sizes are too large to handle labs. |
| 1 | - Need fume hoods, safety goggles. |
| 1 | - Need a provincial lab-safety inspector to tour the facilities at least annually. |

Biology - Time

- | | |
|----|---|
| 21 | - There is not enough time to cover the prescribed course material under the semester system (must allow some time for individual projects) |
| 2 | - Need more time for preparation. |

In-Service

- | | |
|---|---|
| 3 | - Need source of information for keeping up-to-date on new developments in science. |
| 3 | - Need summer school courses for teachers. |
| 2 | - Need more contact with professors and scientists. |
| 2 | - Need provincially supplied periodicals. |

Frequency In-Service - (Continued)

- 2 - Teachers of senior science must be specialists.
- 1 - Need specific lab and work sheets for inexperienced teachers.
- 1 - Workshops should be given by other secondary school science teachers.
- 1 - Workshops must give practical aid in specific areas of science.

Questionnaires

- 3 - No comments.
- 2 - Surveys never bring about any "action".
- 2 - Error in question 49C (lacking #5 response).
- 2 - Clarifications of specific questions.
- 2 - New materials were not available in time to assess the course fairly (not available until September 1978).
- 2 - Question #31 is an "insult" ("more than 6" does not give an accurate picture of the number of hours teachers put into their work outside of the school day).
- 1 - The questionnaire does identify the respondent.
- 1 - The questionnaire is one of the best received so far.
- 1 - Questionnaire tries to accommodate too many grade levels thus some responses are inappropriate.